(19) Japanese Patent Office (JP)

(12) Publication of Patent Application (A)

(11) Publication Number of Patent Application: JP-A-2001-345262 (P2001-345262A)

(43) Date of Publication of Application: Dec. 14th, 2001

(51) Int. Cl.^{7} Identification Number

H 01 L 21/027	
G 03 F 7/20	521

FI Theme code (reference)

G 03 F 7/20	521	5F046
H 01 L 21/30	516F	
	502G	
	515D	
	516Z	

Request for Examination: not made

Number of claim: 75 (20 pages in total)

(21) Application Number: 2001-85531 (P2001-85531)

(22) Application Date: March 23rd, 2001

(31) Priority Number: 2000-93686 (P2000-93686)

(32) Priority Date: March 30, 2000

(33) Priority Country: Japan (JP)

(71) Applicant: 000001007

Canon Inc.

3-30-2, Shimomaruko, Ota-ku, Tokyo

(72) Inventor: Shinichi HARA

3-30-2, Shimomaruko, Ota-ku, Tokyo

Canon Inc.

(72) Inventor: Yutaka TANAKA

3-30-2, Shimomaruko, Ota-ku, Tokyo

Canon Inc.

(74) Agent: Patent Attorney Yasunori OHTSUKA (others 3)

(72) Inventor: Kazuyuki HARUMI

3-30-2, Shimomaruko, Ota-ku, Tokyo

Canon Inc.

(72) Inventor: Yu HIRABAYASHI

3-30-2, Shimomaruko, Ota-ku, Tokyo

Canon Inc.

F term (reference) 5F046 AA22 AA28 BA04 BA05 CA08

CB19 CB20 CB23 CB24 DA04

DA27 DB03 DB04 DD06

(54) [Title of the Invention]

EXPOSURE APPARATUS, GAS SUBSTITUTING METHOD, SEMICONDUCTOR DEVICE MANUFACTURING METHOD, SEMICONDUCTOR MANUFACTURING FACTORY AND MAINTENANCE METHOD OF EXPOSURE APPARATUS

(57) [Abstract]

[Problem] To reduce air immediately in a container which seals the surroundings of an optical path of exposure light in a semiconductor exposure apparatus.

[Means of Resolution] An exposure apparatus has a chamber having an optical element therein and surrounding a predetermined region, a seal container surrounding the chamber, and a pump reducing a pressure within the chamber, wherein the pressure of the seal container is also reduced when the pressure within the chamber is reduced.

[Claims]

[Claim 1]

An exposure apparatus comprising:

a chamber having an optical element therein and surrounding a predetermined region;

a seal container surrounding the chamber; and

a pump reducing a pressure within the chamber,

wherein a pressure of the seal container is also reduced when the pressure within the chamber is reduced.

[Claim 2]

The exposure apparatus according to claim 1, wherein the chamber is supported by the seal container.

[Claim 3]

The exposure apparatus according to claim 1 or 2, further comprising a displacement mechanism producing a displacement between the chamber and the seal container.

[Claim 4]

The exposure apparatus according to any one of claims

1 to 3, further comprising a measuring instrument measuring a position relationship between a reference member and the chamber.

[Claim 5]

The exposure apparatus according to any one of claims 1 to 4, wherein the position relationship between the reference member and the chamber is measured, and based on the measurement result, the displacement mechanism is controlled.

[Claim 6]

The exposure apparatus according to claim 1, wherein the chamber is supported by a surface plate supporting a barrel holding the optical element.

[Claim 7]

The exposure apparatus according to claim 6, wherein the seal container is coupled to the surface plate via a movable body.

[Claim 8]

The exposure apparatus according to claim 7, wherein the movable body is a bellows.

[Claim 9]

The exposure apparatus according to any one of claims 1 to 8, wherein the seal container has a transmitting window passing light therethrough.

[Claim 10]

The exposure apparatus according to claim 9, wherein the

transmitting window is made of fluorine compound glass.

[Claim 11]

The exposure apparatus according to claim 9 or 10, wherein the transmitting window is supported to be movable to the seal container.

[Claim 12]

The exposure apparatus according to any of claims 1 to 11, wherein the seal container has an openable/closable door.

[Claim 13]

The exposure apparatus according to any one of claims 1 to 8, further comprising an air vent for communication between the chamber and the seal container.

[Claim 14]

The exposure apparatus according to claim 13, wherein the air vent is openable and closable.

[Claim 15]

The exposure apparatus according to any one of claims 1 to 14, wherein the pump discharges gas within the seal container.

[Claim 16]

The exposure apparatus according to claim 15, wherein the pump discharges gas within the chamber via an air vent provided for the chamber by discharging gas within the seal container.

[Claim 17]

The exposure apparatus according to any one of claims 1 to 16, wherein the pump discharges gas within the chamber.

[Claim 18]

The exposure apparatus according to any one of claims 1 to 17, wherein the chamber has at least part of an optical element of an illumination optical unit therein.

[Claim 19]

The exposure apparatus according to any one of claims 1 to 18, wherein the chamber has at least part of an optical element of a projection optical unit therein.

[Claim 20]

The exposure apparatus according to any one of claims 1 to 19, wherein an inert gas is supplied after the pressure within the chamber is reduced.

[Claim 21]

The exposure apparatus according to claim 20, wherein the inert gas is at least one of helium and nitrogen.

[Claim 22]

The exposure apparatus according to any one of claims 1 to 21, wherein the reduction of the pressure within the chamber is performed a plurality of times.

[Claim 23]

The exposure apparatus according to any one of claims 1 to 22, wherein the chamber has a gas supply port and a gas discharge port.

[Claim 24]

The exposure apparatus according to any one of claims 1 to 23, wherein the chamber surrounds at least part of an optical path of light in a vacuum ultraviolet region.

[Claim 25]

An exposure apparatus comprising:

a chamber having an optical element therein and surrounding a predetermined region;

a mechanism achieving an inert gas atmosphere in the chamber; and

a seal container surrounding the chamber,

wherein a purity of the inert gas within the chamber is higher than a purity of an inert gas within the seal container.

[Claim 26]

The exposure apparatus according to claim 25, wherein the purity of the inert gas within the seal container is higher than a purity of an inert gas outside the seal container.

[Claim 27]

The exposure apparatus according to claim 25 or 26, wherein the mechanism exhausts gas within the chamber into a vacuum before achieving the inert gas atmosphere in the chamber.

[Claim 28]

The exposure apparatus according to any one of claims 25 to 27, wherein the seal container has a transmitting window

passing light therethrough.

[Claim 29]

The exposure apparatus according to claim 28, wherein the transmitting window is made of fluorine compound glass.

[Claim 30]

The exposure apparatus according to any one of claims 25 to 29, wherein the seal container has an openable/closable door.

[Claim 31]

The exposure apparatus according to any one of claims 1 to 30, further comprising an air vent for communication between the chamber and the seal container.

[Claim 32]

The exposure apparatus according to claim 28, wherein the air vent is openable and closable.

[Claim 33]

The exposure apparatus according to any one of claims 1 to 32, wherein the chamber has at least part of an optical element of an illumination optical unit therein.

[Claim 34]

The exposure apparatus according to any one of claims 1 to 33, wherein the chamber has at least part of an optical element of a projection optical unit therein.

[Claim 35]

The exposure apparatus according to any one of claims

1 to 34, wherein the inert gas is at least one of helium and nitrogen.

[Claim 36]

The exposure apparatus according to any one of claims 25 to 35, wherein the chamber surrounds at least part of an optical path of light in a vacuum ultraviolet region.

[Claim 37]

An exposure apparatus comprising:

a chamber having an optical element therein and surrounding a predetermined region;

a mechanism achieving an inert gas atmosphere in the chamber; and

a seal container surrounding the chamber,

wherein a pressure within the chamber is higher than a pressure within the seal container.

[Claim 38]

The exposure apparatus according to claim 37, wherein a pressure of an inert gas within the seal container is higher than a pressure of an inert gas outside the seal container.

[Claim 39]

The exposure apparatus according to claim 37 or 38, wherein the mechanism exhausts gas within the chamber into a vacuum before achieving the inert gas atmosphere in the chamber.

[Claim 40]

The exposure apparatus according to any one of claims 37 to 39, wherein the seal container has a transmitting window passing light therethrough.

[Claim 41]

The exposure apparatus according to claim 40, wherein the transmitting window is made of fluorine compound glass.

[Claim 42]

The exposure apparatus according to any one of claims 37 to 41, wherein the seal container has an openable/closable door.

[Claim 43]

The exposure apparatus according to any one of claims 37 to 42, further comprising an air vent for communication between the chamber and the seal container.

[Claim 44]

The exposure apparatus according to claim 43, wherein the air vent is openable and closable.

[Claim 45]

The exposure apparatus according to any one of claims 37 to 44, wherein the chamber has at least part of an optical element of an illumination optical unit therein.

[Claim 46]

The exposure apparatus according to any one of claims 37 to 45, wherein the chamber has at least part of an optical element of a projection optical unit therein.

[Claim 47]

The exposure apparatus according to any one of claims 37 to 46, wherein the inert gas is at least one of helium and nitrogen.

[Claim 48]

The exposure apparatus according to any one of claims 37 to 47, wherein the chamber surrounds at least part of an optical path of light in a vacuum ultraviolet region.

[Claim 49]

A gas substituting method comprising:

a step of reducing a pressure of the interior of a chamber having an optical element therein;

a step of reducing a pressure of a seal container surrounding the chamber; and

a step of supplying an inert gas into the interior of the chamber.

[Claim 50]

The gas substituting method according to claim 49, wherein a displacement is produced between the chamber and the seal container.

[Claim 51]

The gas substituting method according to claim 50, wherein a position relationship between a reference member and the chamber is measured, and based on the measurement result, the displacement mechanism is controlled.

[Claim 52]

The gas substituting method according to any one of claims 49 to 51, wherein a door provided for the seal container is opened and closed.

[Claim 53]

The gas substituting method according to any one of claims 49 to 52, wherein an air vent provided for the chamber is opened and closed.

[Claim 54]

The gas substituting method according to any one of claims 49 to 53, wherein the pump discharges gas within the seal container.

[Claim 55]

The gas substituting method according to claim 54, wherein the pump discharges gas within the chamber via an air vent provided for the chamber by discharging gas within the seal container.

[Claim 56]

The gas substituting method according to any one of claims 49 to 55, wherein the pump discharges gas within the chamber.

[Claim 57]

The gas substituting method according to any one of claims 49 to 56, wherein an inert gas is supplied after the pressure within the chamber is reduced.

[Claim 58]

The gas substituting method according to claim 57, wherein the inert gas is at least one of helium and nitrogen.

[Claim 59]

The gas substituting method according to any one of claims 49 to 58, wherein the reduction of the pressure within the chamber is performed a plurality of times.

[Claim 60]

A gas substituting method comprising: a step of supplying an inert gas to the interior of a chamber having an optical element therein; a step of supplying an inert gas to a seal container surrounding the chamber; and

a step of performing control such that a purity of the inert gas within the chamber is higher than a purity of the inert gas within the seal container.

[Claim 61]

The gas substituting method according to claim 60, further comprising a step of performing control such that the purity of the inert gas within the seal container is higher than a purity of an inert gas outside the seal container.

[Claim 62]

A gas substituting method comprising:

a step of supplying an inert gas to the interior of a chamber having an optical element therein;

a step of supplying an inert gas to a seal container

surrounding the chamber; and

a step of performing control such that a pressure of the inert gas within the chamber is higher than a pressure of the inert gas within the seal container.

[Claim 63]

The gas substituting method according to claim 62, further comprising a step of performing control such that the pressure of the inert gas within the seal container is higher than a pressure of an inert gas outside the seal container.

[Claim 64]

A semiconductor device manufacturing method comprising:

a step of installing a group of manufacturing apparatuses for various processes including the exposure apparatus according to any one of claims 1 to 48 in a semiconductor manufacturing factory; and

a step of manufacturing a semiconductor device with a plurality of processes by using the group of manufacturing apparatuses.

[Claim 65]

The semiconductor device manufacturing method according to claim 64, further comprising a step of connecting the group of manufacturing apparatuses through a local area network; and

a step of performing data communication of information about at least one apparatus of the group of manufacturing apparatuses between the local area network and an external

network outside the semiconductor manufacturing factory.

[Claim 66]

The semiconductor device manufacturing method according to claim 65, wherein the data communication is used to access a database provided by a vendor or a user of the exposure apparatus through the external network to acquire maintenance information of the manufacturing apparatus or data communication is performed with a semiconductor manufacturing factory different from the semiconductor manufacturing factory through the external network to perform production management.

[Claim 67]

A semiconductor manufacturing factory comprising:

a group of manufacturing apparatuses for various processes including the exposure apparatus according to any one of claims 1 to 48;

a local area network connecting the group of manufacturing apparatuses; and

a gateway allowing access from the local area network to an external network outside the factory,

wherein data communication of information about at least one apparatus of the group of manufacturing apparatuses is allowed through connection with the external network.

[Claim 68]

A maintenance method of the exposure apparatus according

to any one of claims 1 to 48 installed in a semiconductor manufacturing factory, comprising:

a step of supplying a maintenance database connected to an external network outside the semiconductor manufacturing factory by a vendor or a user of the exposure apparatus;

a step of permitting access to the maintenance database from the semiconductor manufacturing factory through the external network; and

a step of transmitting maintenance information accumulated in the maintenance database to the semiconductor manufacturing factory through the external network.

[Claim 69]

A storage medium in the exposure apparatus according to any one of claims 1 to 48 further comprising:

a display for displaying maintenance information;

a network interface for connection to a database managing the maintenance information; and

a computer accessing the database on a network through the network interface and executing software for communication transmitting and receiving the maintenance information of the exposure apparatus, wherein data communication of the maintenance information of the exposure apparatus is allowed through a computer network.

[Claim 70]

The exposure apparatus according to claim 69, wherein

the software for communication is connected to an external network outside a factory in which the exposure apparatus is installed, a user interface for access to a maintenance database provided by a vendor or a user of the exposure apparatus is provided on the display, and acquisition of information from the database through the external network is allowed.

[Claim 71]

An exposure apparatus comprising:

a chamber having an optical element therein and surrounding a predetermined region;

a seal container surrounding the chamber; and

a pump reducing a pressure within the seal container,

wherein the chamber is supported on a surface plate and the seal container is coupled to the surface plate via a movable body for absorbing deformation.

[Claim 72]

The exposure apparatus according to claim 71, wherein the movable body is a bellows.

[Claim 73]

The exposure apparatus according to claim 71, further comprising a second movable body for absorbing deformation of the seal container,

wherein the second movable body holds a transmitting window and the transmitting window is held in a predetermined

relationship with the optical element in the interior.

[Claim 74]

The exposure apparatus according to claim 71, wherein the movable body is a bellows.

[Claim 75]

The exposure apparatus according to claim 73, wherein the second movable body is a bellows.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a gas substituting method, and more particularly, to a method of substituting an inert gas for air as an atmosphere gas in an optical path of vacuum ultraviolet light in a semiconductor exposure apparatus using the vacuum ultraviolet light as a light source. The present invention also relates to an exposure apparatus in which such gas substitution is performed.

[0002]

[Prior Art]

As semiconductor devices tend to have a higher degree of integration and a smaller size, high resolution is needed in an exposure apparatus such as a stepper. Since the resolution is proportional to the wavelength of exposure light, the exposure light has a shorter and shorter wavelength from a g-line in a visible light region (with a wavelength of 436

nm) to an i-line in an ultraviolet region (with a wavelength of 365 nm). In recent years, KrF excimer laser light (with a wavelength of 248 nm) is used, and the use of ArF excimer laser light (with a wavelength of 193 nm), F2 laser light (with a wavelength of 157 nm), and even Ar2 laser light (with a wavelength of 126 nm) is being contemplated.

[0003]

In a wavelength region of the ArF excimer laser or less, however, light is absorbed by oxygen in air and the transmittance thereof is reduced. To address this, in an exposure apparatus employing the ArF excimer laser, nitrogen substitutes for gas in the majority of the optical path of exposure light. Since light is slightly absorbed by nitrogen in a wavelength region of 190 nm or less (vacuum ultraviolet), nitrogen needs to be substituted by another gas (an inert gas other than nitrogen) which allows the light to pass therethrough. Of such gasses, it is contemplated that it is most desirable to substitute the atmosphere around the optical path of exposure light and around optical elements by helium in view of safety, excellent heat conductivity, and small changes in refractive index with temperature.

[0004]

Typically, for substituting the air in the optical path of exposure light by another gas, the optical path is contained in a seal container, one end of the seal container is used as

a supply port of the gas and the other end is used as a discharge port, the substitution gas is supplied through the supply port, and a gas flow path is formed in the seal container such that the substitution gas fills the entire optical path. Then, the gas in the seal container is substituted with the effects of convection and molecular diffusion.

[0005]

When the gas is supplied into the seal container, the air originally present in the container is pushed out. At this stage, the concentration near the discharge port is changed only slightly. Next, the air diluted with the convection is discharged. In this stage, the concentration of the original air is rapidly reduced exponentially. Thereafter, the rate of the concentration reduction is gradually slowed down. It is contemplated that this is because the gas substitution in a stagnation point where the gas does not flow easily is promoted mainly by the molecular diffusion.

[0006]

When the gas substitution in the stagnation point where the gas does not flow easily is promoted only by the molecular diffusion, it takes an extremely long time to reduce the concentration of the air originally present in the container.

[0007]

On the other hand, in the wavelength region of vacuum ultraviolet light, a continuous absorbing band for oxygen is

present, so that light is significantly absorbed at a high oxygen concentration in the optical path. For use as the exposure apparatus, the oxygen concentration needs to be approximately 1 ppm or lower. When the substitution of air by helium is attempted with the conventional method, however, the gas substitution in the stagnation point is mainly performed only by the molecular diffusion and it takes a long time to achieve the gas substitution to a desired oxygen concentration.

[0008]

[Means for Solving the Problems]

In view of the abovementioned problem of the prior art, it is an object of the present invention to reduce air immediately in a container which seals the surroundings of an optical path of exposure light in a semiconductor exposure apparatus.

[0009]

To achieve the abovementioned object, an exposure apparatus according to the present invention includes a chamber having an optical element therein and surrounding a predetermined region, a seal container surrounding the chamber, and a pump reducing the pressure within the chamber, wherein the pressure of the seal container is also reduced when the pressure within the chamber is reduced.

[0010]

It is desirable that the chamber be supported by the seal container.

[0011]

It is desirable to have a displacement mechanism producing a displacement between the chamber and the seal container.

[0012]

It is desirable to have a measuring instrument measuring a position relationship between a reference member and the chamber. It is preferable to measure the position relationship between the reference member and the chamber, and to control the displacement mechanism based on the measurement result.

[0013]

Desirably, the seal container has a transmitting window passing light therethrough. The transmitting window is preferably made of fluorine compound glass. The seal container desirably has an openable/closable door.

[0014]

It is desirable to have an air vent for communication between the chamber and the seal container. The air vent is preferably openable and closable.

[0015]

The pump desirably discharges gas within the seal container. The pump desirably discharges gas within the

chamber via an air vent provided for the chamber by discharging gas within the seal container.

[0016]

Desirably, the pump discharges gas within the chamber.

[0017]

The chamber desirably has at least part of an optical element of an illumination optical unit therein.

[0018]

The chamber desirably has at least part of an optical element of a projection optical unit therein.

[0019]

An inert gas is desirably supplied after the pressure within the chamber is reduced. The inert gas is preferably at least one of helium and nitrogen.

[0020]

Desirably, the reduction of the pressure within the chamber is performed a plurality of times.

[0021]

The chamber desirably has a gas supply port and a gas discharge port.

[0022]

The chamber desirably surrounds at least part of an optical path of light in a vacuum ultraviolet region.

[0023]

Another exposure apparatus according to the present

invention includes a chamber having an optical element therein and surrounding a predetermined region, a mechanism achieving an inert gas atmosphere in the chamber, and a seal container surrounding the chamber, wherein the purity of the inert gas within the chamber is higher than the purity of an inert gas within the seal container.

[0024]

The purity of the inert gas within the seal container is desirably higher than the purity of an inert gas outside the seal container.

[0025]

The mechanism desirably exhausts gas within the chamber into a vacuum before achieving the inert gas atmosphere in the chamber.

[0026]

The seal container desirably has a transmitting window passing light therethrough. The transmitting window is preferably made of fluorine compound glass. The seal container desirably has an openable/closable door. It is desirable to have an air vent for communication between the chamber and the seal container. The air vent is preferably openable and closable.

[0027]

The chamber desirably has at least part of an optical element of an illumination optical unit therein.

[0028]

The chamber desirably has at least part of an optical element of a projection optical unit therein. The inert gas is desirably at least one of helium and nitrogen. The chamber desirably surrounds at least part of an optical path of light in a vacuum ultraviolet region.

[0029]

Another exposure apparatus according to the present invention includes a chamber having an optical element therein and surrounding a predetermined region, a mechanism achieving an inert gas atmosphere in the chamber, and a seal container surrounding the chamber, wherein the pressure within the chamber is higher than the pressure within the seal container.

[0030]

Desirably, the pressure of an inert gas within the seal container is higher than the pressure of an inert gas outside the seal container.

[0031]

The mechanism desirably exhausts gas within the chamber into a vacuum before achieving the inert gas atmosphere in the chamber.

[0032]

The seal container desirably has a transmitting window passing light therethrough. The transmitting window is preferably made of fluorine compound glass.

[0033]

The seal container desirably has an openable/closable door.

[0034]

It is desirable to have an air vent for communication between the chamber and the seal container. The air vent is desirably openable and closable.

[0035]

The chamber desirably has at least part of an optical element of an illumination optical unit therein.

[0036]

The chamber desirably has at least part of an optical element of a projection optical unit therein.

[0037]

The inert gas is desirably at least one of helium and nitrogen.

[0038]

The chamber desirably surrounds at least part of an optical path of light in a vacuum ultraviolet region.

[0039]

To achieve the abovementioned object, a gas substituting method according to the present invention includes a step of reducing the pressure of the interior of a chamber having an optical element therein, a step of reducing the pressure of a seal container surrounding the chamber, and a step of

supplying an inert gas into the interior of the chamber.

[0040]

Another gas substituting method according to the present invention includes a step of supplying an inert gas to the interior of a chamber having an optical element therein, a step of supplying an inert gas to a seal container surrounding the chamber, and a step of performing control such that the purity of the inert gas within the chamber is higher than the purity of the inert gas within the seal container.

[0041]

Another gas substituting method according to the present invention includes a step of supplying an inert gas to the interior of a chamber having an optical element therein, a step of supplying an inert gas to a seal container surrounding the chamber, and a step of performing control such that the pressure of the inert gas within the chamber is higher than the pressure of the inert gas within the seal container.

[0042]

A semiconductor device manufacturing method using the abovementioned exposure apparatus falls within the scope of the present invention.

[0043]

A semiconductor manufacturing factory including the abovementioned exposure apparatus falls within the scope of the present invention. A maintenance method of the

abovementioned exposure apparatus falls within the scope of the present invention.

[0044]

[Mode for Carrying Out the Invention]

<Embodiment of Exposure Apparatus>

Fig. 1 is an overall configuration diagram showing an embodiment of an exposure apparatus according to the present invention.

[0045]

In Fig. 1, a laser apparatus 1 serving as a light source of the exposure apparatus is installed on a floor or downstairs independently of the exposure apparatus. The laser apparatus 1 is an excimer laser apparatus which generates vacuum ultraviolet light in a wavelength region of wavelengths of 160 nm or less. While an F2 excimer laser having a generating wavelength near 157 nm is used in the present embodiment, another light source generating a wavelength in an ultraviolet region may be used such as an Ar2 laser having a generating wavelength near 126 nm.

[0046]

A laser beam emitted by the laser apparatus 1 is directed into an apparatus body through mirrors 2 and 3. A chamber 4 has a sealed structure in order to block the surroundings of an optical path including the mirrors 2 and 3 from the ventilation of outside air. A glass 5 is placed in a light

exit portion from the chamber 4. The glass 5 passes the laser beam from the laser apparatus 1 exiting from the interior of the chamber 4 and directs the laser beam to a housing 6, later described. The glass 5 is held to ensure the sealed state of the chamber 4.

[0047]

The glass 5 is formed of a glass material made of fluorine compound. Specifically, it is possible to use any of fluorite (CaF_2), magnesium fluoride (MgF_2), barium fluoride (BaF_2), SrF_2, and fluorine doped quartz. These glass materials have high transmittance for light of a wavelength of 157 mm or less. The details within the chamber 4 are described later.

[0048]

The light passed through the glass 5 is incident on the housing 6 and illuminates a reticle 8 via a mirror 7 in the housing 6.

[0049]

The details of the housing 6 are also described later.

[0050]

The reticle 8 is placed on a reticle holder 10 mounted on a reticle stage 9. The reticle stage 9 is driven by a reticle stage driving unit, not shown, in a Y direction which is a direction within a plane orthogonal to an optical axis and is a scanning direction. A bar mirror 11 is fixed to the reticle stage 9. The position of the bar mirror is measured by an

interferometer 12 to measure the position of the reticle stage. In Fig. 1, the only one interferometer 12 is illustrated and shown to be driven in the Y direction of coordinates in Fig. 1 that is the scanning direction. However, an interferometer and a bar mirror may also be placed in an X direction of the coordinates in Fig. 1 to measure the position of the reticle stage in the two, X and Y, axes.

[0051]

A pattern (not shown) drawn on the reticle 8 is scaled down at a predetermined magnification by a projection optical unit 13 and is transferred by exposure to a wafer 14 having a photosensitive material applied thereto. The details of the projection optical unit 13 are also described later.

[0052]

The wafer 14 is placed on a wafer chuck 16 mounted on a wafer stage 15. The wafer stage 15 is driven by a wafer stage driving unit, not shown, in the XY direction which is a direction within a plane orthogonal to the optical axis. A bar mirror 17 is fixed to the wafer stage. The position of the bar mirror is measured by an interferometer 18 to measure the position of the wafer stage. In Fig. 1, the only one interferometer 18 is illustrated and shown to be driven in the Y direction of the coordinates in Fig. 1 that is the scanning direction. However, since the wafer stage needs to step-move the wafer in the X direction after scanning exposure, an

interferometer and a bar mirror may also be placed in the X direction of the coordinates in Fig. 1 to measure the position of the wafer stage in the two, X and Y, axes.

[0053]

Next, an apparatus structure is described.

[0054]

A main surface plate 20 is mounted on a plurality of legs 19. A stage surface plate 21 and a barrel surface plate 22 are placed on the main surface plate 20.

[0055]

A reference plane in parallel to the XY plane is provided on the stage surface plate 21. The abovementioned wafer stage 15 moves in the XY direction along the reference plane. In the present embodiment, the wafer stage 15 is supported in a non-contact manner for the stage surface plate 21 by a guide using a gas bearing. The guide for supporting the wafer stage is not limited to the gas bearing, and it is possible to use a rolling type guide using a ball or a roller, or a sliding type guide.

[0056]

An air-conditioning duct 23 and an outer casing 24 are placed on the barrel surface plate 22 in addition to the projection optical unit 13 and the interferometer 18 described above. Since the interferometer 18 is supported on the barrel surface plate 22 which supports the projection optical unit

13, the position of the wafer stage 15 can be measured relative to the projection optical unit 13. The air-conditioning duct 23 blows gas from a circulating unit, later described, in a direction orthogonal to the optical axis of the projection optical unit 13 via an inside ULPA filter 23' (Ultra Low Penetration Air-filter). The air-conditioning duct 23 stabilizes the space generally surrounded by an interferometer optical path 18' of the interferometer 18, the wafer 14, and the barrel surface plate 22 at a predetermined temperature. This can reduce fluctuations of the interferometer optical path 18' and reduce object deformation due to a temperature change in the space. The air-conditioning duct 23 also reduces the concentration of a light absorbing material (for example, oxygen) in the exposure light path from the termination of the projection optical unit 13 to the wafer 14.

[0057]

The abovementioned reticle stage 9 moves in the Y direction (and, in some cases, in the X direction) which is the scanning direction along a reference plane provided for the outer casing 24. In the present embodiment, the reticle stage 15 is supported in a non-contact manner for the outer casing 24 by a guide using an air bearing. The guide for supporting the reticle stage is not limited to the gas bearing, and it is possible to use a rolling type guide using a ball or a roller, or a sliding type guide.

[0058]

The outer casing 24 surrounds an upper portion of the projection optical unit 13 above an upper surface of the barrel surface plate 22 and has an opening portion 24' in an upper portion so as to pass exposure light pencils. The interferometer 12, an air-conditioning duct 25, and the housing 6 (in Fig. 1, the connecting portion of the housing 6 and the outer casing is omitted by a break line) are mounted on the outer casing 24 in addition to the reticle stage 9 described above. Since the interferometer 12 is supported on the outer casing 24 provided integrally with the projection optical unit 13, the position of the reticle stage 9 can be measured relative to the projection optical unit 13. The air-conditioning duct 25 blows gas from the circulating unit, later described, in the direction orthogonal to the optical axis of the projection optical unit 13 via an inside ULPA filter 25'. The air-conditioning duct 25 stabilizes an interferometer optical path 12' of the interferometer 12, the reticle 8, and the space surrounding the reticle at a predetermined temperature. This can reduce fluctuations of the interferometer optical path 12' and reduce object deformation due to a temperature change in the space surrounding the reticle. The air-conditioning duct 25 reduces the concentration of a light absorbing material (for example, oxygen) in the optical path before and after the reticle 8.

[0059]

In the present embodiment, a chamber 26 has a sealed structure which accommodates the apparatus body and blocks ventilation of outside air. A movable member 27 is formed of bellows made of stainless steel or the like, and has a structure which can couple the surroundings of the legs 19 to the chamber 26, ensure the hermeticity of the chamber 26, and absorb a relative displacement of the legs 19 and the main surface plate 20.

[0060]

A movable member 28 is formed of bellows made of stainless steel or the like, and has a structure which can couple the chamber 4 to the chamber 26, ensure the hermeticity of the chamber 4 and the chamber 26, and absorb a relative displacement of the chamber 4 and the chamber 26 mounted on a support stage 30.

[0061]

A movable member 29 is formed of bellows made of stainless steel or the like, and has a structure which can couple the chamber 4 to the housing 6, ensure the hermeticity of the chamber 4 and the housing 6, and absorb a relative displacement of the chamber 4 and the housing 6.

[0062]

While the movable members 27, 28, and 29 are provided by using the bellows made of stainless steel in the present

embodiment, the present invention is not limited thereto as long as the structure can ensure the hermeticity and absorb a relative displacement. It is possible to use a metal bellows made of alloy of nickel or titanium, or a bellows made of resin. A magnetic fluid seal may be used in addition to the bellows.

[0063]

A load lock room 31 is a load lock room used in carrying the reticle 8 in or out and includes gate valves 32 and 33 freely opened and closed by a driving unit, not shown. A support stage 34 is a support stage for the reticle 8. A reticle carrying robot 35 performs supply and recovery of the reticle to and from the reticle holder 10.

[0064]

A load lock room 36 is a load lock room used in carrying the wafer 14 in or out and includes gate valves 37 and 38 freely opened and closed by a driving unit, not shown. A support stage 39 is a support stage for the wafer 14. A wafer carrying robot 40 performs supply and recovery of the wafer to and from the wafer chuck 16.

[0065]

Next, description is made of an environmental control and temperature control method within the chambers 4 and 26 and the load lock rooms 31 and 36.

[0066]

A gas supply source 51 supplies one of nitrogen gas and

helium gas as inert gas. The two gasses have excellent transmittance for F2 laser light. The gas supply source 51 supplies gas substantially containing no oxygen. "Substantially containing no oxygen" means that oxygen largely affecting the apparatus performance is not contained, and means an oxygen concentration at least lower than the oxygen concentration needed for the chamber 4 and the like.

[0067]

The gas from the gas supply source 51 is directed to a gas supply port 53 provided for one end of the chamber 4 on the side of the light source via piping 52, passes in the chamber 4, and then is discharged through a gas discharge port 54 provided for the other end of the chamber 4 on the side of the exposure apparatus, and is discharged to an exhaust mechanism 56 via piping 55.

[0068]

Next, a gas flow path within the chamber 4 is described with reference to Fig. 2. Components identical to those in Fig. 1 are designated with the same reference numerals and description thereof is omitted.

[0069]

A laser beam emitted by the laser apparatus 1 is reflected by the mirror 2 and is shaped into a predetermined beam form by a beam shaping optical unit 201. Then, the laser beam is applied to an optical integrator 210 at a predetermined

magnification by condensing lenses 204 and 207. The optical integrator 210 includes fine lenses arranged two-dimensionally and illuminates a conjugate plane 219 to the reticle 8 (Fig. 1) with superimposition via a condensing lens 213.

[0070]

The beam shaping optical unit 201 is supported on a support stage 202 including an air vent 203. The condensing lens 204 is supported on a support stage 205 including an air vent 206. The condensing lens 207 is supported on a support stage 209 including an air vent 208. The optical integrator 210 is supported on a support stage 211 including an air vent 212. The condensing lens 213 is supported on a support stage 214 including an air vent 215.

[0071]

The gas from the gas supply port 53 flows along the optical path within the chamber 4, passes through the air vents 203, 206, 208, 212, 215, and 218 in order, and is discharged through the gas discharge port 54.

[0072]

The concept of the gas flow path within the chamber 4 is shown by arrows in Fig. 2.

[0073]

The flow path is provided to pass through the space between the optical elements within the chamber 4 successively

to allow the efficient gas substitution of the atmosphere in the space between the optical elements.

[0074]

While the glass 5 is formed of parallel plane plate in the present embodiment, the present invention is not limited thereto, and another transmitting element may be used such as a lens and a prism. In addition, while the present embodiment has been described in conjunction with the case where a fly eye lens is used as the optical integrator, the present invention is not limited thereto, and a rod integrator may be used, a plurality of fly eye lenses may be used in series, or an optical unit provided by combining the fly eye lens with the rod integrator may be used.

[0075]

The optical unit within the chamber 4 is combined with the optical unit within the housing 6, later described, to form an illumination optical unit which illuminates the reticle.

[0076]

Returning to Fig. 1, the description of the exposure apparatus of the present embodiment is continued.

[0077]

In Fig. 1, a gas supply source 57 supplies one of nitrogen gas and helium gas.

[0078]

The gas from the gas supply source 57 is directed to a

gas supply port 59 provided for the housing 6 or the bellows 29 via piping 58, passes in the housing 6, and is discharged into the chamber 6 through a gas discharge port 60 provided for one end of the housing 6.

[0079]

The gas flow path within the housing 6 is described with reference to Fig. 2 in which components identical to those in Fig. 1 are designated with the same reference numerals and description thereof is omitted.

[0080]

A masking blade 301 has an opening in rectangular shape which defines the illumination range of the reticle 8. The rectangular opening dimensions can be changed by driving with driving means, not shown, depending on the reticle pattern and the position of the reticle 8. A light shield plate 301' which forms the abovementioned rectangular opening in the masking blade 301 is placed near a conjugate plane 219 to the reticle 8. Condensing lenses 302 and 305 project the image of the rectangular opening portion formed by the masking blade 301 onto the reticle 8 at a predetermined magnification.

[0081]

Thus, as described above, the optical unit within the housing 6 forms a portion of the illumination optical unit which illuminates the reticle 8 together with the optical unit within the chamber 4.

[0082]

The light shield plate 301' has a structure which moves along a guide, not shown. While the present embodiment has been described in conjunction with the use of a gas bearing which is a non-contact bearing, the present invention is not limited thereto, and it is possible to use a rolling type guide using a boll or a roller, or a sliding type guide.

[0083]

The condensing lens 302 is supported on a support stage 304 having an air vent 303. The condensing lens 305 is supported on a support stage 306.

[0084]

The gas from the gas supply port 59 flows along the optical path within the housing 6, passes through the air vent 303 provided in the support stage 4, passes through the optical path between the condensing lenses 302 and 305, and then is discharged through the gas discharge port 60. The concept of the gas flow path within the housing 6 is shown by the arrows in Fig. 2. The flow pass is provided to pass between the optical elements within the housing 6 successively to allow the efficient gas substitution of the atmosphere between the optical elements.

[0085]

While the gas discharged through the gas discharge port 60 is directly flowed into the chamber 26 in the present

embodiment, the present invention is not limited thereto. The gas from the gas discharge port 60 may be directed to the optical unit placed in the optical path from the housing 6 to the wafer 14, for example to the projection optical unit 13, may be passed in the projection optical unit, and then may be discharged into the chamber 26. Alternatively, the gas discharged from the gas discharge port 60 may be directly recovered.

[0086]

While the optical unit within the housing 6 shown in Fig. 2 is an imaging optical unit using the condensing lens unit, it is possible to use a reflection-refraction type optical unit or a reflection type optical unit instead.

[0087]

While the use of the rectangular opening shape in the masking blade 301 is described in the present embodiment, it is possible to use an arc-shaped opening having a predetermined curvature.

[0088]

In the present embodiment, the gas support port 59 is provided in one end of the housing 6 on the side of the light source, and the gas discharge port 60 is provided in one end of the housing 6 on the side of the reticle. However, the present invention is not limited thereto. For example, the gas supply port may be provided in one end of the housing 6 on the side of the reticle and the gas discharge port may be

provided in one end of the housing 6 on the side of the light source. Particularly, in view of the gas purity and the like of the atmosphere within the housing 6, it may be desirable that the portion where the masking blade, which is a movable body, is located be set as the downstream side.

[0089]

The abovementioned gas circulating method is a substituting method of the gas within the chamber 4 and within the housing 6 during exposure. However, since the atmosphere within the chamber 4 and within the housing 6 is air before exposure, merely flowing the inert gas results in a long time taken to reduce the oxygen concentration in the optical path.

[0090]

To address this, in the present invention, before the inert gas is supplied into the chamber 4 and the housing 6, evacuation is performed in the chamber 4 and the housing 6 once or a plurality of times to discharge the air originally present in the interior.

[0091]

For example, when the chamber 4 is deformed due to a pressure difference between the interior and the exterior of the chamber 4 at the time of the evacuation of the chamber 4, the position of the optical element held by the chamber 4 is undesirably shifted.

[0092]

Thus, in the present invention, the chamber 4 and the housing 6 are surrounded by a seal container in order to reduce the pressure difference between the interior and exterior of the chamber 4 and the housing 6. In performing the evacuation of the chamber 4 and the housing 6, the interior of the seal container is controlled to be at a pressure substantially the same as the pressure within the chamber 4 and the housing 6. This can reduce the pressure difference between the interior and the exterior of the chamber 4 and the housing 6 to suppress the deformation at the time of the evacuation of the chamber 4 and the housing 6.

[0093]

The abovementioned seal container is described with reference to Fig. 4.

[0094]

In Fig. 3, a seal container 101 surrounds the chamber 4 and the housing 6 having the illumination optical unit. A vacuum pump 103 forcedly exhausts gas within the seal container 101 to perform the evacuation of the seal container 101.

[0095]

An air vent 105A allows the atmosphere within the chamber 4 to communicate with the atmosphere within the seal container. When the vacuum pump 103 forcedly exhausts the gas in the seal container 101, the pressure of the atmosphere within the seal container 101 is reduced, and the gas within the chamber 4 is

discharged into the seal container 101 through the air vent 105A. This can perform the evacuation of the chamber 4 and achieve the pressure within the chamber 4 substantially the same as the pressure within the seal container.

[0096]

An air vent 105B allows the atmosphere within the housing 6 to communicate with the atmosphere within the seal container. When the vacuum pump 103 forcedly exhausts the gas in the seal container 101, the pressure of the atmosphere within the seal container 101 is reduced, and the gas within the housing 6 is discharged into the seal container 101 through the air vent 105B. This can perform the evacuation of the housing 6 and achieve the pressure within the housing 6 substantially the same as the pressure within the seal container.

[0097]

The abovementioned configuration can be used to perform the evacuation of the chamber 4 and the housing 6 and to reduce the pressure difference between the interior and the exterior of the chamber 4 and the housing 6. This can reduce the deformation of the chamber 4 and the housing 6 at the time of the evacuation.

[0098]

While Fig. 3 shows the chamber 4 and the housing 6 which are surrounded by the same seal container, the present invention is not limited thereto, and they may be surrounded

by separate seal containers. In addition, the seal container 101 may double as the abovementioned chamber 26.

[0099]

When the seal container 101 is evacuated, a pressure difference may be produced between the interior and the exterior of the seal container 101 to cause deformation. When the seal container 101 supports the chamber 4, for example, it is undesirable to transfer the deformation of the seal container 101 to the chamber 4. Thus, in the present invention, a displacement mechanism for producing a displacement is provided between the seal container 101 and the chamber 4.

[0100]

When the seal container 101 is deformed, displacement mechanisms 107A and 107B produce a displacement between the seal container 101 and the chamber 4 in response to the deformation of the seal container so as not to transfer the deformation to the chamber 4. A reference member 111 provided externally is used as a reference of positioning the illumination optical unit, and the distance between the chamber 4 and the reference member 111 is detected by an interferometer 113. The displacement mechanisms 107A and 107B are controlled on the basis of the position information detected by the interferometer 113.

[0101]

The displacement mechanisms 107A and 107B can desirably

control the chamber 4 in six-axis directions. The displacement mechanisms 107A and 107B may support chamber 4 for the seal container. In addition, the displacement mechanisms 107A and 107B desirably provide the displacement in a non-contact manner.

[0102]

While Fig. 3 shows the displacement mechanisms only for the chamber 4, such a mechanism is provided similarly for the housing 6.

[0103]

The seal container 101 needs to pass exposure light therethrough during exposure. Thus, a transmitting window 115 is provided for the seal container 101 in the present invention. The transmitting window 115 is held to ensure the hermeticity within the seal container 101 and has a structure resistant to a pressure difference, if any, between the interior and the exterior of the seal container. The transmitting window 115 is formed of glass material made of fluorine compound. Specifically, it is possible to use any of fluorite (CaF_2), magnesium fluoride (MgF_2), barium fluoride (BaF_2), SrF_2, and fluorine doped quartz. These glass materials have high transmittance for light having a wavelength of 157 nm or less. While the transmitting window 115 is provided by using a parallel plane plate in the present embodiment, the present invention is not limited thereto, and another transmitting

element may be used such as a lens, a prism, and a film.

[0104]

After the chamber 4 and the housing 6 are evacuated as described above and the air originally present within the chamber 4 and the housing 6 is discharged, the inert gas is supplied through the gas supply port 53 or the gas supply port 59 to circulate the atmosphere within the chamber 4 and the housing 6 as described above. At this point, the air vents 105A and 105B are closed to ensure the path of the gas described in Fig. 2.

[0105]

When the seal container is evacuated, the transmitting window 115 may be distorted or displaced. To address this, the transmitting window 115 may be held by a bellows (movable body) on the seal container and may be moved by an actuator, not shown, relative to the seal container. The bellows for the transmitting window is substantially similar to a bellows for a transmitting window 165 in the projection optical unit, later described.

[0106]

In Fig. 3, the air vents 105A and 105B are used to reduce the pressure difference between the interior of the seal container 101 and the interior of the chamber 4 and the housing 6. However, the means for reducing the pressure difference is not limited thereto. For example, as shown in Fig. 4, it

is possible to provide vacuum pumps 103A, 104B, and 103C for the seal container 101, the chamber 4, and the housing 6, respectively, and to measure the internal pressures and control the vacuum pumps based on the measurement results. In addition, as shown in Fig. 6, later described, it is possible to provide vacuum pumps for the chamber 4 and the housing 6 and to provide air vents between the chamber 4 and the seal container 101 and between the housing 6 and the seal container 101.

[0107]

In Fig. 3, when the pressure within the chamber 4 and within the housing 6 during exposure is substantially the same as the external pressure, the hermeticity of the seal container 101 does not need to be held. In such a case, the transmitting window 115 provided for the seal container 101 is not particularly required, and for example, an openable/closable door which is closed in evacuation may be used.

[0108]

In Fig. 3, the purity of the inert gas within the chamber 4 and the housing 6 needs to be increased particularly during exposure. Thus, the pressure within the chamber 4 and the housing 6 during the exposure may be a positive pressure. This can prevent the inflow of gas from outside the chamber 4 or the housing 6 to maintain the purity of the inert gas within the chamber 4 and the housing 6. If the atmosphere within the seal container 101 is also the inert gas atmosphere, a reduction

in purity of the gas in the chamber 4 or the housing 6 can be reduced even when gas flows into the chamber 4 or the housing 6 from the seal container 101. Thus, it is desirable to provide a supply port or a discharge port of the inert gas for the seal container 101.

[0109]

When the seal container 101 is filled with the inert gas as described above, a high purity equal to the purity within the chamber 4 and the housing 6 is not necessarily desired. For example, the purity may be higher in the order within the chamber 4 (or the housing 6), then within the seal container 101, and outside the seal container.

[0110]

When a positive pressure is set within the chamber 4 or the housing 6 as described above, the pressure may be controlled to be higher in the order within the chamber 4 (or the housing 6), then within the seal container 101, and outside the seal container, for example.

[0111]

When the chamber 4 and the housing 6 are evacuated a plurality of times, it is desirable to have a step of filling the chamber 4 and the housing 6 with the inert gas between the evacuation steps. The evacuation performed a plurality of times can reduce the pressure difference between the interior and the exterior at each evacuation step to reduce deformation.

In addition, the oxygen concentration can be sufficiently reduced in a short time.

[0112]

Returning to Fig. 1, description is continued. In Fig. 1, the gas from the gas supply source 57 is directed to a gas supply port 62 provided for one end of the projection optical unit 13 on the side of the wafer via piping 61, passes through the projection optical unit 13, and then is discharged into the chamber 26 from a gas discharge port 63 provided for the other end of the projection optical unit 13 on the side of the reticle.

[0113]

The gas flow path within the projection optical unit 13 is described with reference to Fig. 5. Components identical to those in Fig. 1 are designated with the same reference numerals and description thereof is omitted.

[0114]

The pattern drawn on the reticle 8 is scaled down and projected onto the wafer 14 by lenses 402, 405, 408, 411, 414, 417, and 420. Reference numeral 401 shows a barrel of the group of lenses described above.

[0115]

The lens 402 is supported on a support stage 404 including the gas discharge port 63. The lens 405 is supported on a support stage 407 including an air vent 406. The lens 408 is

supported on a support stage 410 including an air vent 409. The lens 411 is supported on a support stage 413 including an air vent 412. The lens 414 is supported on a support stage 416 including an air vent 415. The lens 417 is supported on a support stage 419 including an air vent 418. The lens 420 and the support stages 407, 407, 410, 413, 416, and 419 are supported on the barrel 401.

[0116]

The gas from the gas support port 62 passes through the air vents 418, 415, 412, 409, and 406 provided for the respective support stages in order and is discharged through the gas discharge port 63. The concept of the gas flow path within the projection optical unit 13 is shown by arrows in Fig. 4. The flow path is provided to pass between the optical elements within the projection optical unit 13 successively to allow the efficient gas substitution of the atmosphere between the optical elements within the projection optical unit 13.

[0117]

While the gas discharged from the gas discharge port 63 is directly flowed into the chamber 26 in the present embodiment, the present invention is not limited thereto. The gas from the gas discharge port 63 may be directed to the optical unit placed in the optical path from the glass 5 (Figs. 1 to 4) to the wafer 14, for example to housing 6 (Fig. 1, Fig. 4), and

be discharged into the chamber 26 via the housing 6. Alternatively, the gas discharged through the gas discharge port 63 may be directly recovered.

[0118]

While the refraction type optical unit is used as the projection optical unit 13 in the present embodiment, the present invention is not limited thereto, and a reflection-refraction type optical unit or a reflection type optical unit may be used instead.

[0119]

The abovementioned gas circulating method is a substituting method of the gas within the projection optical unit 13 during exposure. However, since the atmosphere within the projection optical unit 13 is air before exposure, merely flowing the inert gas results in a long time taken to reduce the oxygen concentration in the optical path.

[0120]

To address this, in the present invention, before the inert gas is supplied into the projection optical unit 13, the projection optical unit 13 is evacuated once or a plurality of times to discharge the air originally present in the interior.

[0121]

When the projection optical unit 13 is deformed due to a pressure difference between the interior and exterior of the

projection optical unit 13 at the time of the evacuation of the projection optical unit 13, the positions of the lenses of the projection optical unit 13 are undesirably shifted.

[0122]

Thus, in the present invention, the projection optical unit 13 is surrounded by a seal container in order to reduce the pressure difference between the interior and exterior of the projection optical unit 13. In performing the evacuation of the projection optical unit 13, the interior of the seal container is controlled to be at a pressure substantially the same as the pressure within the projection optical unit 13. This can reduce the pressure difference between the interior and the exterior of the projection optical unit 13 to suppress the deformation at the time of the evacuation of the projection optical unit 13.

[0123]

The abovementioned seal container is described with reference to Fig. 6. In Fig. 6, a seal container 151 surrounds the projection optical unit 13. A vacuum pump 153 forcedly exhausts gas within the seal container 151 to evacuate the seal container 101.

[0124]

An air vent 155 allows the atmosphere within the projection optical unit 13 to communicate with the atmosphere within the seal container 151. When the vacuum pump 153

forcedly exhausts the gas in the projection optical unit 13, the pressure of the atmosphere within the projection optical unit 13 is reduced, and the gas within the seal container 151 is discharged through the air vent 155 via the projection optical unit 13. This can perform the evacuation of the projection optical unit 13 and the seal container 151 and achieve the pressure within the projection optical unit 13 substantially the same as the pressure within the seal container 151.

[0125]

The abovementioned configuration can be used to perform the evacuation of the projection optical unit 13 and to reduce the pressure difference between the interior and the exterior of the projection optical unit 13. This can reduce the deformation of the projection optical unit 13 at the time of the evacuation.

[0126]

The seal container 151 may double as the abovementioned chamber 26, the outer casing 24 or the like.

[0127]

When the seal container 151 is evacuated, a pressure difference may be produced between the interior and the exterior of the seal container 151 to cause deformation. If the seal container 151 supports the projection optical unit 13, it is undesirable to transfer the deformation of the seal

container 151 to the projection optical unit 13. Thus, in the present invention, a displacement mechanism for producing a displacement is provided between the seal container 151 and the projection optical unit 13.

[0128]

When the seal container 151 is deformed, displacement mechanisms 157A and 157B produce a displacement between the seal container 151 and the projection optical unit 13 in response to the deformation of the seal container 151 so as not to transfer the deformation to the projection optical unit 13. The reference member 111 provided externally is used as a reference of positioning the projection optical unit 13, and the distance between the projection optical unit 13 and the reference member 111 is detected by an interferometer 163. The displacement mechanisms 157A and 157B are controlled on the basis of the position information detected by the interferometer 163.

[0129]

The displacement mechanisms 157A and 157B can desirably control the projection optical unit 13 in six-axis directions. The displacement mechanisms 157A and 157B may support the projection optical unit 13 for the seal container 151. In addition, the displacement mechanisms 157A and 157B desirably provide the displacement in a non-contact manner.

[0130]

The seal container 151 needs to pass exposure light therethrough during exposure. Thus, transmitting windows 165A and 165B are provided for the seal container 151 in the present invention. The transmitting windows 165A and 165B are held to ensure the hermeticity within the seal container 151 and have a structure resistant to a pressure difference, if any, between the interior and the exterior of the seal container 151. In view of deformation of the seal container 151, as shown in Fig. 7, later described, the transmitting windows may be held by a bellows and be moved by an actuator. The transmitting windows 165A and 165B are formed of glass material made of fluorine compound. Specifically, it is possible to use any of fluorite (CaF_2), magnesium fluoride (MgF_2), barium fluoride (BaF_2), SrF_2, and fluorine doped quartz. These glass materials have high transmittance for light having a wavelength of 157 nm or less. While the transmitting windows 165A and 165B are provided by using a parallel plane plate in the present embodiment, the present invention is not limited thereto, and another transmitting element may be used such as a lens, a prism, and a film.

[0131]

After the projection optical unit 13 is evacuated as described above and the air originally present within the projection optical unit 13 is discharged, the inert gas is supplied through the gas supply port 62 to circulate the

atmosphere within the projection optical unit 13 as described above. At this point, the air vent 155 is closed to ensure the path of the gas described in Fig. 5.

[0132]

In Fig. 6, the air vent 155 is used to reduce the pressure difference between the interior of the seal container 151 and the interior of the projection optical unit 13. However, the means for reducing the pressure difference is not limited thereto. For example, similarly to the case shown in Fig. 4, it is possible to provide vacuum pumps 153A and 153B for the seal container 151 and the projection optical unit 13, respectively, and to measure the internal pressures and control the vacuum pumps based on the measurement results. In addition, similarly to the case shown in Fig. 3 described above, it is possible to provide a vacuum pump for the seal container and to provide an air vent between the projection optical unit and the seal container.

[0133]

In Fig. 6, when the pressure of the projection optical unit 13 during exposure is substantially the same as the external pressure, the hermeticity of the seal container 151 does not need to be held. In such a case, the transmitting windows 165A and 165B provided for the seal container 151 are not particularly required, and for example, an openable/closable door which is closed in evacuation may be

used.

[0134]

In Fig. 6, the purity of the inert gas within the projection optical unit 13 needs to be increased particularly during exposure. Thus, the pressure within the projection optical unit 13 during the exposure may be a positive pressure. This can prevent the inflow of gas from outside the projection optical unit 13 to maintain the purity of the inert gas within the projection optical unit 13. If the atmosphere within the seal container 151 is also the inert gas atmosphere, a reduction in purity of the gas in the projection optical unit 13 can be reduced even when gas flows into the projection optical unit 13 from the seal container 151. Thus, it is desirable to provide a supply port or a discharge port of the inert gas for the seal container 151.

[0135]

When the seal container 151 is filled with the inert gas as described above, a high purity equal to the purity within the projection optical unit 13 is not necessarily desired. For example, the purity may be higher in the order within the projection optical unit 13, then within the seal container 151, and outside the seal container.

[0136]

When a positive pressure is set within the projection optical unit 13 as described above, the pressure may be

controlled to be higher in the order within the projection optical unit 13, then within the seal container 101, and outside the seal container, for example.

[0137]

When the projection optical unit 13 is evacuated a plurality of times, it is desirable to have a step of filling the projection optical unit 13 with the inert gas between the evacuation steps. The evacuation performed a plurality of times can reduce the pressure difference between the interior and the exterior at each evacuation step to reduce deformation. In addition, the oxygen concentration can be sufficiently reduced in a short time.

[0138]

Next, description is made of a modification of the seal container which surrounds the projection optical unit with reference to Fig. 7. In Fig. 7, components identical to those in Fig. 6 are designated with the same reference numerals and detailed description thereof is omitted.

[0139]

In Fig. 7, the projection optical unit 13 is supported on the barrel surface plate 22. A seal container 151A covers a portion of the projection optical unit 13 above the barrel surface plate 22. A seal container 151B covers a portion of the projection optical unit 13 below the barrel surface plate 22. Although not shown, the space within the seal container

151A communicates with the space within the seal container 151B.

[0140]

A vacuum pump 153A evacuates the space between the seal containers 151A and 151B and the projection optical unit 13. A vacuum pump 153B evacuates the gas in the projection optical unit 13. This achieves the pressure within the projection optical unit 13 substantially equal to the pressure within the seal container 151 similarly to the abovementioned case. An air vent may be provided and a vacuum pump may be provided similarly to the abovementioned case.

[0141]

When the seal containers 151A and 151B are evacuated, a pressure difference may be produced between the interior and the exterior of the seal containers 151A and 151B to cause deformation. It is undesirable to transfer the deformation of the seal containers 151A and 151B to the projection optical unit 13.

[0142]

Thus, in the example of Fig. 7, the seal container 151A and the barrel surface plate 22 are coupled to each other with hermeticity maintained via a stainless bellows 167A which is a movable body. Similarly, the seal container 151B is coupled with hermeticity maintained via a stainless bellows 167B which is a movable body. Thus, even when the pressure difference

between the interior and the exterior of the seal containers 151A and 151B deforms the seal containers 151A and 151B, the influence of the deformation is not transferred to the barrel surface plate. As a result, the influence of the deformation of the seal containers 151A and 151B is not transferred to the projection optical unit 13. It should be noted that the barrel surface plate 22 may not be deformed easily even when the pressures of the interiors of the seal containers 151A and 151B are reduced. Thus, even when the seal containers 151A and 151B are evacuated, the deformation has a small influence on the projection optical unit 13.

[0143]

The deformation of the seal containers 151A and 151B may distort or displace the transmitting windows 165A and 165B provided for the seal container. Thus, the transmitting windows 165A and 165B are held to be movable relative to the seal containers 151A and 151B by bellows (movable bodies) 169A and 169B, respectively, and are movable relative to the seal container by an actuator (not shown). When the seal containers 151A and 151B are deformed, the transmitting windows 165A and 165B are positioned by the actuator in a predetermined position relationship with the projection optical unit 13. The holding of the transmitting windows 165A and 165B is not limited to the use of the bellows, and any method may be used as long as the transmitting windows 165A and 165B may be held to be movable

relative to the seal containers 151A and 151B to hold the hermeticity within the seal container.

[0144]

It goes without saying that the abovementioned bellows 169A and 169B are not required when the abovementioned openable/closable door is provided instead of the transmitting windows 165A and 165B.

[0145]

Returning again to Fig. 1, the description is continued.

[0146]

The gas discharged into the chamber 26 through the gas discharge ports 60 and 63 is discharged through a circulating outlet 70 of the chamber 26 and is directed to an inlet port 73 of a gas circulating unit 72 via piping 71. The gas distributed into predetermined flow amounts within the gas circulating unit 72 is discharged through distribution ports 74a, 74b, 74c, and 74d of the gas circulating unit 72.

[0147]

The gas discharged through the distribution port 74a is directed via piping 75a to a down flow duct 76 which flows down almost all of the gas within the chamber 26, and is blown into the chamber 26 via a ULPA filter 76' within the down flow duct 76.

[0148]

The gas discharged through the distribution port 74b is

directed to a partial duct 25 via piping 75b and is blown out to the space near the reticle 8 and the interferometer optical path 12' as described above.

[0149]

The gas discharged through the distribution port 74c is directed to a gas inlet port 41 of the external casing 24 via piping 75c, passes through the space between the projection optical unit 13 and the external casing 24, and then is discharged into the chamber 26 through the opening portion 24' of the external casing 24.

[0150]

The gas discharged through the distribution port 74d is directed to a partial duct 23 via piping 75d and is blown out to the space near the wafer 14 and the interferometer optical path 18' as described above.

[0151]

Although not shown, a chemical filter is provided for removing impurities within the gas from the inlet port in the gas circulating unit 72.

[0152]

A temperature adjusting mechanism, not shown, is provided in the gas circulating unit 72. The temperature adjusting mechanism performs control at a predetermined temperature in response to an instruction from a control apparatus 78 based on the detection results of thermometers

77a to 77d provided in the exposure apparatus.

[0153]

The gas from the abovementioned gas supply source 57 may be controlled at a predetermined temperature within the gas supply source 57 in advance, or the piping path may be determined such that a predetermined temperature is reached by the time the gas in the piping 58 and 61 arrives at the supply ports 59 and 62 via the space for which the temperature is controlled as described above.

[0154]

In Fig. 1, after part of the gas within the chamber 26 is recovered through piping 80 and the pressure thereof is increased to a predetermined gas pressure, a high-pressure gas supply apparatus 79 supplies the gas to a gas bearing (not shown) of the wafer stage 15 via piping 81a, to a gas bearing (not shown) of the reticle stage 9 via piping 81b, and to a gas bearing (not shown) of the masking blade 301 (Fig. 4) via piping 81c. The inert gas which is a purge gas within the chamber 26 can be used as a working fluid for the gas bearing to maintain the environment within the chamber 26 in a predetermined state.

[0155]

Next, the internal schematic configuration of the high-pressure gas supply apparatus 79 is described with reference to Fig. 8.

[0156]

The pressure of the gas from the piping 80 is detected by a pressure gage 701 and a control valve 702 is controlled by the control apparatus 78 (Fig. 1) to control the gas at a predetermined flow rate. The gas controlled at the predetermined flow rate by the control valve passes through a recovery pump 703, is stored in a buffer tank 704, pressurized to a predetermined pressure by a compressor 705, and then is flowed to the piping 81a to 81c. The gas flow path is branched between the pressure gage 701 and the control valve 702 and is discharged with an exhaust pump 706. The exhaust amount is controlled by a mass-flow controller 708 based on the detection result of a pressure gage 707 provided for the buffer tank 704 when the exhaust is required. The mass-flow controller 708 is controlled by the control apparatus 78 (Fig. 1) based on the detection result of the pressure gage 707.

[0157]

According to the abovementioned configuration, the atmospheric pressure within the chamber 26 can be controlled at a constant level at all times. This can maintain the optical characteristics susceptible to pressure variations, for example the performance of the projection optical unit 13 (Fig. 1).

[0158]

It is also possible to maintain the relative pressure

difference between the atmospheric pressure within the chamber 26 and the outside air pressure at a predetermined value. This can be achieved by using the pressure gage 701 as a differential pressure gage and detecting the pressure difference between the pressure within the piping 80 (that is, within the chamber 26) and the outside air pressure.

[0159]

In addition, the relative pressure difference between within the chamber 26 and within the chamber 4 can be maintained at a predetermined value. This can be achieved by detecting the relative pressure difference between within the piping 80 (that is, within the chamber 26) and with the chamber 4 using the abovementioned differential pressure gage.

[0160]

The chamber 26 may be provided with the functions of the above-mentioned seal container 101 or seal container 151.

[0161]

In Fig. 1, the gas from the gas supply source 57 is supplied to the load lock room 36 for the wafer via piping 82, passes through piping 83 while substituting for the interior, and is discharged to an exhaust mechanism 86. Similarly, the gas from the gas supply source 57 is supplied to the load lock room 31 for the reticle via piping 84, passes through piping 85 while substituting for the interior, and is discharged to the exhaust mechanism 86.

[0162]

For the timing of the gas supply, after the gate valve 32 or 37 is opened and the reticle or the wafer is mounted on the support stage 34 or 39, the gate valve 32 or 37 is closed, and then a valve (not shown) provided for the gas supply source and a valve (not shown) provided inside the exhaust mechanism 86 are opened in response to an instruction from the control apparatus 78 to perform the gas supply.

[0163]

When the interiors of the load lock rooms 31 and 36 attain predetermined states, the valve is closed in response to an instruction from the control apparatus 78 to stop the gas supply. In addition, the gate valves 33 and 38 are opened to cause the carrying means 35 and 40 to carry the reticle 8 and the wafer 14 into the apparatus.

[0164]

When the reticle 8 or the wafer 14 is carried out of the apparatus, the gas supply is started with the gate valves 32, 33, 37, and 38 closed, and the gas supply is stopped when the interior of each load lock room reaches the predetermined state. Next, the gate valves 33 and 38 are opened and the carrying means 35 and 40 carry the reticle 8 and the wafer 14 out of the apparatus and then mount them on the support stage 34 and 39 within the load lock rooms 31 and 39. After the mounting, the gate valves 33 and 38 are closed and the gate valves 32

and 37 are opened to take out the reticle 8 and the wafer 14 by means, not shown.

[0165]

In the above description, the reticle 8 and the wafer 14 are simultaneously carried into or out of the apparatus, it goes without saying that the reticle 8 and the wafer 14 can be individually carried into or out of the apparatus.

[0166]

The load lock rooms 31 and 36 are subjected to the gas substitution in order not to affect the environments within the chamber 26 when the gate valves 33 and 38 are opened. This is well known.

[0167]

When a pellicle (not shown) is used for the purpose of preventing attachment of dust onto the pattern surface of the reticle 8, the space surrounded by the reticle 8, the pellicle, and a pellicle frame (not shown) for supporting the pellicle is desirably subjected to the purge gas substitution, and it is desirable to use a pressure-equalizing hole pellicle frame (having an air vent for communication between the interior and the exterior of the pellicle frame).

[0168]

An exhaust port 87 is an exhaust port for discharging the gas within the chamber 26.

[0169]

At the time of start of the operation of the apparatus, the interior of the chamber 26 and the interior of the gas circulating unit 72 are in an air state.

[0170]

Thus, at the time of start-up of the apparatus, the gas supply from the gas supply source 57 to the projection optical unit 13 and the housing 6 is started, and the exhaust is performed to the exhaust mechanism 86 from the exhaust port 87 through piping 88. The ON/OFF of the exhaust operation is performed by the control apparatus 78 controlling a valve (not shown) provided within the exhaust means 86.

[0171]

When the interior of the chamber 26 and the circulating unit reach a predetermined substitution state, the exhaust from the discharge port 87 is stopped to enter an exposure operative state.

[0172]

The determination of the timing to stop the exhaust from the exhaust port 87 may be made by the control apparatus 78 automatically determining whether or not a predetermined time has elapsed since the exhaust start to issue an exhaust stop instruction, or by placing a gas detector (not shown) at a predetermined point within the chamber 26 or within the circulating unit to allow the control apparatus 78 to automatically make a determination based on the detection

result to issue an exhaust stop instruction.

[0173]

In starting the operation of the apparatus, when it is desirable that the substitution states of the chambers 4 and 26 should reach a predetermined state in a shorter time, or when the substitution is finished in a shorter time to improve the throughput since the air release and the substitution state are repeated for each replacement of reticles or wafers within the load lock rooms 31 and 36, a vacuum pump may be used to exhaust the air forcedly from exhaust means 56 and 86 to evacuate the chambers 4 and 26 and the load lock rooms 31 and 36 before the gas purge is performed in the method described above. In this case, the chambers 4 and 26 and the load lock rooms 31 and 36 need to have sufficient rigidity to prevent their deformation in the vacuum state from affecting the apparatus performance.

[0174]

In the embodiment shown in Fig. 1, the movable members 27, 28, and 29 are used. Even when the chambers 4 and 26 are deformed in the vacuum state, the deformation can be prevented from being directly transferred to the adjacent component.

[0175]

A series of operations described above for evacuating the chambers and the load lock rooms and then supplying the gas may be repeated a plurality of times as required. As

compared with the case where the evacuation is performed only once to perform the purge, when the operations are repeated a plurality of times, the attained degree of vacuum within the chambers and the load lock rooms may be a relatively low (with a high absolute pressure) to reduce the cost of the vacuum pump or the parts for vacuum significantly. In the substitution method of the present invention, helium is supplied after the last evacuation is finished, and nitrogen is desirably used in the purge before that.

[0176]

According to the embodiment shown in Fig. 1, even when the interior of the chamber 4 is released to the air due to maintenance or the like, the chamber 26 can maintain the purge state. In contrast, when the interior of the chamber 26 is released to air, the chamber 4 can maintain the purge state.

[0177]

<Embodiment 2>

Fig. 14 is a diagram for explaining Embodiment 2 according to the present invention. A modification of the seal container which covers the illumination optical unit is described with reference to Fig. 14.

[0178]

In Fig. 14, components identical to those in Fig.3 are designated with the same reference numerals and description thereof is omitted.

[0179]

In Fig. 14, a chamber 4 and a housing 6 constituting an illumination optical unit are supported on an illumination unit surface plate 102. A seal container 101 covers the chamber 4 and the housing 6.

[0180]

A vacuum pump 103A produces a vacuum in the internal space between the seal container 101 and the chamber 4 and the housing 6. Similarly, a vacuum pump 103B produces a vacuum in the interior of the chamber 4, and a vacuum pump 103C produces a vacuum in the interior of the housing 6. This allows the pressures within the chamber 4 and the housing 6 to be substantially the same as the pressure within the seal container 101.

[0181]

As described in Embodiment 1, an air vent may be provided between the chamber 4 and the seal container 101 or between the housing 6 and the seal container 101 and a vacuum pump may be provided for any of them.

[0182]

When the seal container 101 is evacuated, a pressure difference may be produced between the interior and the exterior of the seal container 101 to cause deformation. It is undesirable to transfer the influence of the deformation of the seal container 101 to the chamber 4 or the housing 6.

Thus, in the configuration of Fig. 14, the seal container 101 and the illumination unit surface plate 1022 are coupled to each other with hermeticity maintained by absorbing the deformation due to the pressure difference via a stainless bellows 1167 which is a movable body. Thus, even when the pressure difference between the interior and the exterior of the seal container 101 deforms the seal container 101, the influence of the deformation is not transferred to the surface plate. As a result, the influence of the deformation of the seal container 101 is not transferred to the chamber 4 and the housing 6.

[0183]

The illumination unit surface plate 1022 is not deformed easily even when the pressure of the interior of the seal container 101 is reduced. Even when the seal container 101 is evacuated, the deformation of the illumination unit surface plate 1022 has only a small influence on the chamber 4 and the housing 6.

[0184]

On the other hand, the deformation of the seal container 101 may distort or displace a transmitting window 115 provided for the seal container. To address this, the transmitting window 115 is held to be movable relative to the seal container 101 by a bellows 1169 which is a movable body and is movable relative to the seal container by an actuator, not shown. When

the seal container 101 is deformed due to the pressure difference between the interior and the exterior, the transmitting window 115 is positioned by the actuator in a predetermined position relationship with the housing 6.

[0185]

The holding of the transmitting window 115 is not limited to the use of the bellows, and any material may be used as long as the transmitting window 115 may be held to be movable relative to the seal container 101 to hold hermeticity within the seal container.

[0186]

It goes without saying that the abovementioned bellows 1169 is not required when the abovementioned openable/closable door which is closed by a negative pressure in evacuation as described in Embodiment 1 is provided instead of the transmitting window 115.

[0187]

When the reference member 111 as shown in Fig. 3 is rigidly connected to the surface plate 1022, the positioning with the displacement mechanisms 107A and 107B in Fig. 3 is not required.

[0188]

In the present embodiment, the illumination unit surface plate 1022 for holding the chamber 4 and the housing 6 may be provided integrally with the barrel surface plate 22 (see Fig. 7) for holding the projection optical unit 13 in the embodiment

described above. In addition, the seal container 101 in the present embodiment may be the same component as the seal container 151 (see Fig. 7) in the embodiment described above.

[0189]

Such a configuration in which the chamber is surrounded by the seal container is not limited to the projection optical unit or the illumination unit. For example, a wafer stage space or a reticle stage space may be surrounded by a chamber and the chamber may be surrounded by a seal container. The seal container may be the same component.

[0190]

<Embodiment of Semiconductor Production System>

Next, description is made of an example of a production system of semiconductor devices (such as semiconductor chips including ICs and LSIs, liquid crystal panels, CCDs, thin film magnetic heads, and micromachines). This performs maintenance service such as trouble solution and periodic maintenance of a manufacturing apparatus installed in a semiconductor manufacturing factory or software supply by using a computer network outside the manufacturing factory.

[0191]

Fig. 9 shows the overall system illustrated at a certain angle. In Fig. 9, reference numeral 1101 shows a business of a vendor (apparatus supply manufacturer) which provides the semiconductor device manufacturing apparatus. Conceivable

examples of the manufacturing apparatus include a semiconductor manufacturing apparatus for various processes used in the semiconductor manufacturing factory, for example, front-end equipment (such as a lithography apparatus including an exposure apparatus, a resist processing apparatus, and etching apparatus, a heat-treatment apparatus, a film deposition apparatus, and a planarizing apparatus) and back-end equipment (such as an assembly apparatus and a test apparatus). The business 1101 includes a host management system 1108 for providing maintenance database of the manufacturing apparatus, a plurality of operation terminal computers 1110, and a local area network (LAN) 1109 for connecting the computers to constitute an intranet. The host management system 1108 includes a gateway for connecting the LAN 1109 to the Internet 1105 which is a network outside the business and security functions for limiting accesses from the outside.

[0192]

On the other hand, reference numerals 1102 to 1104 show manufacturing factories of the semiconductor manufacturer as a user of the manufacturing apparatus. The manufacturing factories 1102 to 1104 may be factories belonging to different manufacturers or may be factories (for example, factories for the front-end process and factories for the back-end process) belonging to the same manufacturer. Each of the factories 1102

to 1104 includes a plurality of manufacturing apparatuses 1106, a local area network (LAN) 1111 for connecting the apparatuses to constitute an intranet, and a host management system 1107 serving as a monitor apparatus for monitoring the operation status of each of the manufacturing apparatuses 1106. The host management system 1107 provided for each of the factories 1102 to 1104 includes a gateway for connecting the LAN 1111 in each of the factories to the Internet 1105 which is a network outside the factory.

[0193]

This allows access from the LAN 1111 in each of the factories to the host management system 1108 in the vendor 1101 through the Internet 1105 such that only limited users can have access due to the security functions of the host management system 1108. Specifically, status information (for example, the symptom of the manufacturing apparatus encountering a trouble) representing the operation status of each of the manufacturing apparatuses 1106 is notified from the factory to the vendor through the Internet 1105, and response information to the notification (for example, information indicating how to solve the trouble, software or data for solution), and maintenance information such as the latest software and help information can be received from the vendor.

[0194]

A communication protocol (TCP/IP) generally used in the

Internet is used in the data communication between each of the factories 1102 to 1104 and the vendor 1101 and the data communication through the LAN 1111 in each of the factories. Instead of the use of the Internet as the network outside the factory, a dedicated network (such as an ISDN) with a high level of security accessible by a third party may also be used.

[0195]

The host management system is not limited to that provided by the vendor, and a user may constitute and place a database on an outside network such that the database can be accessed by a plurality of factories of the user.

[0196]

Fig. 10 is a conceptual diagram representing the overall system of the present embodiment taken at a different angle from that in Fig. 9. In the previous example, the plurality of user factories each including the manufacturing apparatus are connected to the management system of the vendor of the manufacturing apparatus through the outside network to perform the data communication of the information of the production management of each factory and at least one of the manufacturing apparatuses through the outside network. In contrast, in the present example, a factory including manufacturing apparatuses of a plurality of vendors is connected to a management system of each of the vendors of the plurality of manufacturing apparatuses through a network outside the

factory such that the data of maintenance information of each manufacturing apparatus is communicated.

[0197]

In Fig. 10, reference numeral 1201 shows a manufacturing factory of a manufacturing apparatus user (semiconductor device manufacturer). In a manufacturing line of the factory, manufacturing apparatuses for performing various processes are introduced, which are an exposure apparatus 1202, a resist processing apparatus 1203, and a film deposition apparatus 1204, by way of example. While only one manufacturing factory 201 is drawn in Fig. 10, a plurality of factories are networked similarly in reality.

[0198]

The apparatuses in the factory are connected to each other through a LAN 1206 to constitute an intranet, and a host management system 1205 manages the operation of the manufacturing line. On the other hand, each of businesses of vendors (apparatus supply manufacturers) including an exposure apparatus manufacturer 1210, a resist processing apparatus manufacturer 1220, and a film deposition apparatus manufacturer 1230 include host management systems 1211, 1221, and 1231 for performing remote maintenance of the equipment supplied thereby, and the system includes a maintenance database and a gateway for an outside network as described above.

[0199]

A host management system 1205 for managing each apparatus within the user manufacturing factory is connected to the management systems 1211, 1221, and 1231 of the vendors of the apparatuses through the Internet which is an outside network or a dedicated network. In the system, if a trouble occurs in any of a series of manufacturing apparatuses in the manufacturing line, the operation of the manufacturing line stops. However, countermeasures can be immediately taken by remote maintenance through the Internet 1200 from the vendor of the apparatus encountering the trouble, so that the stop of the manufacturing line can be minimized.

[0200]

Each of the manufacturing apparatuses placed in the semiconductor manufacturing factory includes a display, a network interface, and a computer for executing software for network access and software for operating the apparatus stored in a storage. Examples of the storage include an in-built memory, a hard disk, or a network file server. The abovementioned software for network access includes a dedicated or a general-purpose web browser to provide a user interface with a screen on a display, for example as shown in Fig. 11.

[0201]

An operator who manages the manufacturing apparatus in

each factory refers to the screen and inputs information such as the type (1401) of the manufacturing apparatus, a serial number (1402), the name of a trouble (1403), the date of occurrence (1404), urgency (1405), symptoms (406), how to solve (407), and progress (408) into entry items on the screen. The input information is transmitted to the maintenance database through the Internet, and the resulting appropriate maintenance information is transmitted back from the maintenance database and shown on the display. The user interface provided by the web browser realizes hyperlink functions (1410 to 1412) as shown, and the operator can access detailed information of each item, take software of the newest version for use in the manufacturing apparatus from a software library provided by the vendor, or take an operation guide (help information) for reference of the operator of the factory.

[0202]

The maintenance information provided by the maintenance management system includes information about the oxygen concentration within the chamber described above. The software library provides the newest software for realizing switching of the gas supply apparatus, control of the oxygen concentration within the chamber and the like.

[0203]

Next, description is made of the production process of the semiconductor device using the manufacturing system

described above. Fig. 12 shows a flow of the overall manufacturing process of the semiconductor device. At step 1 (circuit design), the circuit design of the semiconductor device is performed. At step 2 (mask fabrication), a mask is fabricated on which the designed circuit pattern is formed. At step 3 (wafer manufacturing), a wafer is manufactured by using a material such as silicon. Step 4 (wafer process) is called a front-end process in which the mask and wafer provided as above are used to form an actual circuit on the wafer with a lithography technique. The next step 5 (assembly) is called a back-end process in which the wafer fabricated at step 4 is used to form a semiconductor chip, and this step includes assembly steps such as an assembly step (dicing and bonding) and a packaging step (chip enclosure). At step 6 (test), the semiconductor device fabricated at step 5 is tested with an operation check test, a durability test and the like. After these steps, the semiconductor device is finished and shipped (step 7).

[0204]

The front-end process and the back-end process are performed separately in dedicated factories, and the remote maintenance system described above is used to perform maintenance for each factory. The information for production management or apparatus maintenance is communicated through the Internet or a dedicated network between the front-end

factory and the back-end factory.

[0205]

Fig. 13 shows a detailed flow of the abovementioned wafer process. At step 11 (oxidation), the surface of the wafer is oxidized. At step 12 (CVD), an insulating film is deposited on the wafer surface. At step 13 (electrode formation), an electrode is formed on the wafer with vapor deposition. At step 14 (ion implantation), ions are implanted into the wafer. At step 15 (resist processing), a photosensitive material is applied to the wafer. At step 16 (exposure), the circuit pattern of the mask is printed with exposure to the wafer by using the exposure apparatus described above. At step 17 (development), the exposure wafer is developed. At step 18 (etching), the portions other than the developed resist image are cut away.

[0206]

At step 19 (resist stripping), the unnecessary resist after the etching is removed. These steps are repeatedly performed to form the circuit pattern in a multiple manner on the wafer. Since the manufacturing equipment used in each step is subjected to maintenance by the remote maintenance system described above, troubles can be prevented before they occur, and even when any trouble occur, immediate recovery can be achieved. Thus, the productivity of the semiconductor device can be improved over the prior art.

[0207]

[Advantage of the Invention]

As described above, according to the exposure apparatus of the present invention, the deformation of the chamber including the optical element can be suppressed when the pressure within the chamber is reduced.

[0208]

In addition, according to the exposure apparatus of the present invention, the purity of the inert gas within the chamber can be held high.

[0209]

Furthermore, according to the exposure apparatus of the present invention, the purity of the inert gas within the chamber can be held high.

[Brief Description of the Drawings]

[Fig. 1] An overall configuration diagram showing an exposure apparatus.

[Fig. 2] A configuration diagram showing an illumination optical unit of the exposure apparatus according to the present invention.

[Fig. 3] A configuration diagram showing the illumination optical unit of the exposure apparatus according to the present invention.

[Fig. 4] Another configuration diagram showing the illumination optical unit of the exposure apparatus according

to the present invention.

[Fig. 5] A configuration diagram showing the illumination optical unit of the exposure apparatus according to the present invention.

[Fig. 6] A configuration diagram showing the illumination optical unit of the exposure apparatus according to the present invention.

[Fig. 7] Another configuration diagram showing the illumination optical unit of the exposure apparatus according to the present invention.

[Fig. 8] A diagram for explaining a partial configuration of the illumination optical unit in Fig. 1.

[Fig. 9] A schematic diagram showing the overall system of a computer network.

[Fig. 10] A schematic diagram showing the overall system of the computer network.

[Fig. 11] A diagram showing a display screen of a display apparatus.

[Fig. 12] A diagram showing a flow of a semiconductor device manufacturing process.

[Fig. 13] A diagram showing a flow of a wafer process.

[Fig. 14] A diagram for explaining a modification of a seal container which covers the illumination optical unit as Embodiment 2 according to the present invention.

Fig. 1

coordinate system

Fig. 8

exhaust

Fig. 11

trouble DB input screen

404 date of occurrence

401 type

403 name of a trouble malfunctioning (start-up error)

402 S/N of equipment

405 urgency

406 symptoms LED continues flashing after power-up

407 how to solve power-up again (press red button at start-up)

408 progress provisionally solved

send reset

410 link to result list database

411 software library

412 operation guide

Fig. 12

circuit design (step 1)

mask fabrication (step 2)

wafer manufacturing (step 3)

wafer process (step 4)

assembly (step 5)

test (step 6)

shipment (step 7)

Fig. 13

oxidation (step 11)

CVD (step 12)

electrode formation (step 13)

ion implantation (step 14)

resist processing (step 15)

exposure (step 16)

development (step 17)

etching (step 18)

resist stripping (step 19)

repeat

wafer process

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開2001－345262

（P2001－345262A）

(43)公開日　平成13年12月14日(2001.12.14)

(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード゛(参考)
Ｈ０１Ｌ　21/027		Ｇ０３Ｆ　7/20	５２１	５Ｆ０４６
Ｇ０３Ｆ　7/20	５２１	Ｈ０１Ｌ　21/30	５１６Ｆ	
			５０２Ｇ	
			５１５Ｄ	
			５１６Ｚ	

審査請求　未請求　請求項の数75　ＯＬ　（全 20 頁）

(21)出願番号　特願2001－85531(P2001－85531)

(22)出願日　平成13年３月23日(2001.3.23)

(31)優先権主張番号　特願2000－93686(P2000－93686)

(32)優先日　平成12年３月30日(2000.3.30)

(33)優先権主張国　日本（ＪＰ）

(71)出願人　000001007
キヤノン株式会社
東京都大田区下丸子３丁目30番２号

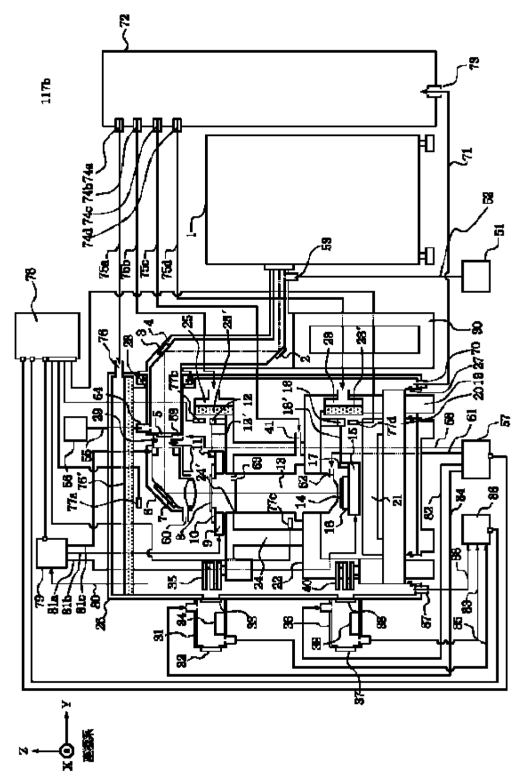
(72)発明者　原　真一
東京都大田区下丸子３丁目30番２号　キヤノン株式会社内

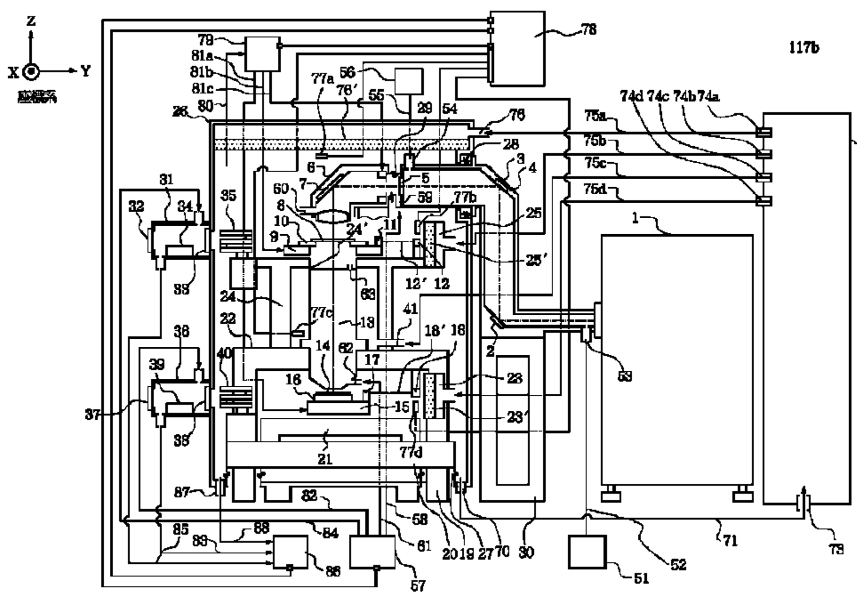
(72)発明者　田中　裕
東京都大田区下丸子３丁目30番２号　キヤノン株式会社内

(74)代理人　100076428
弁理士　大塚　康徳　（外３名）

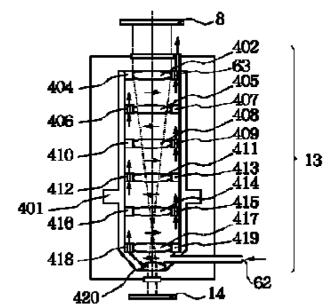
最終頁に続く

(54)【発明の名称】　露光装置、ガス置換方法、半導体デバイス製造方法、半導体製造工場および露光装置の保守方法

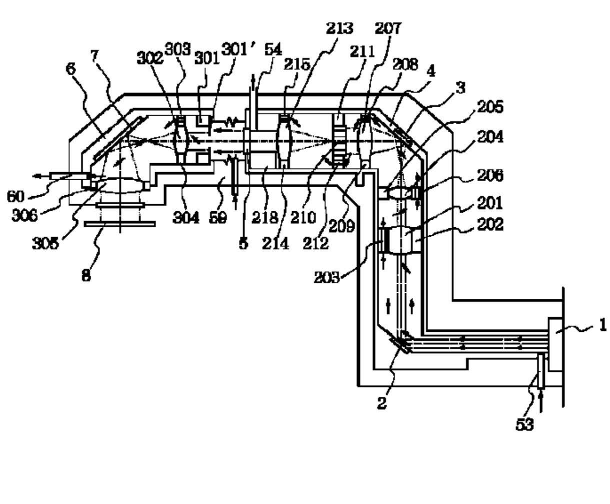




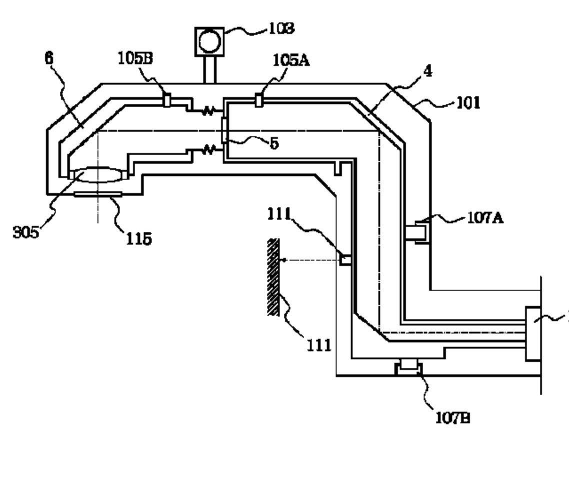
Z
X
Y
78
79
81a
81b
81c
80
26
77a
76'
56
55
29
54
76
28
3
4
6
7
60
8
10
9
24'
11
59
5
77b
25
25'
12' 12
63
24
22
77c
13
41
18'
16
14
62
17
2
23
53
16
15
23'
21
77d
35
31
32
34
33
38
39
40
37
36
87
82
58
85
88
84
83
86
61
57
20
19
27
70
30
51
52
71
73
1
72
75a
75b
75c
75d
74d 74c 74b 74a
117b



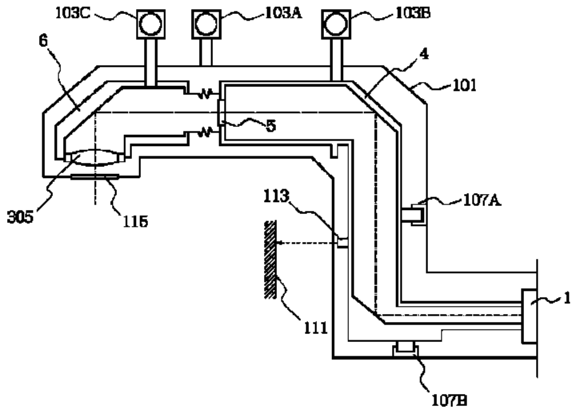
8
402
63
404
405
407
406
408
409
410
411
412
413
401
414
415
416
417
419
418
62
420
14
13

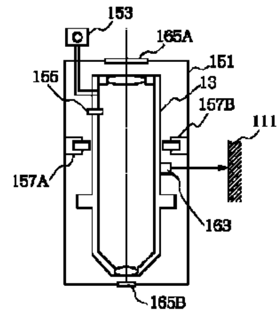


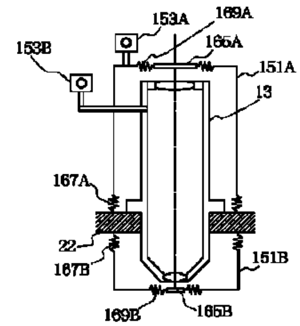
6
7
302
303
301
301'
54
213
215
211
207
208
4
3
205
204
206
201
202
60
306
305
304
59
5
218
214
210
212
209
8
203
1
2
53

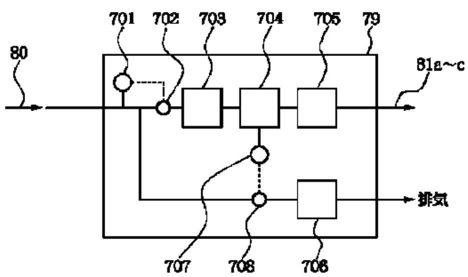


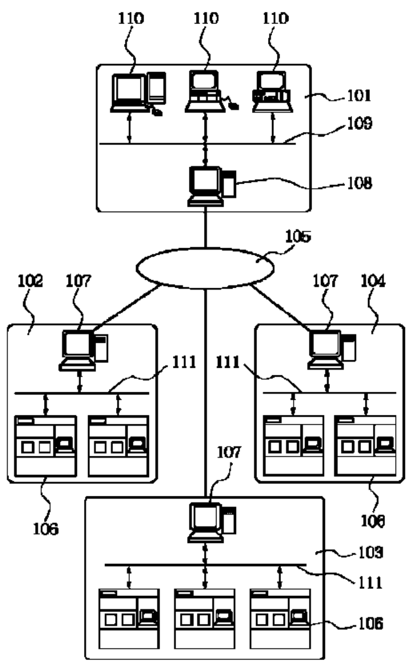
103
6
105B
105A
4
101
5
305
115
111
107A
111
1
107B

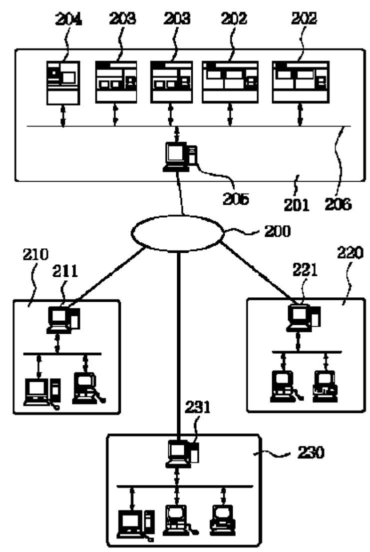

103C
103A
103B
6
4
101
5
305
115
113
107A
111
1
107B

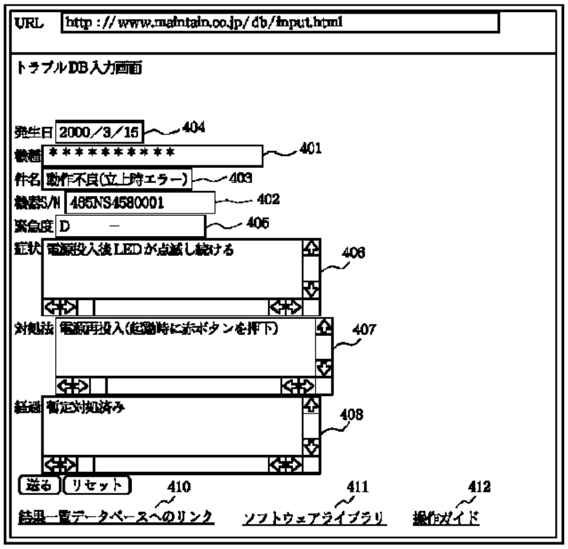

153
165A
151
155
13
157B
111
157A
163
165B

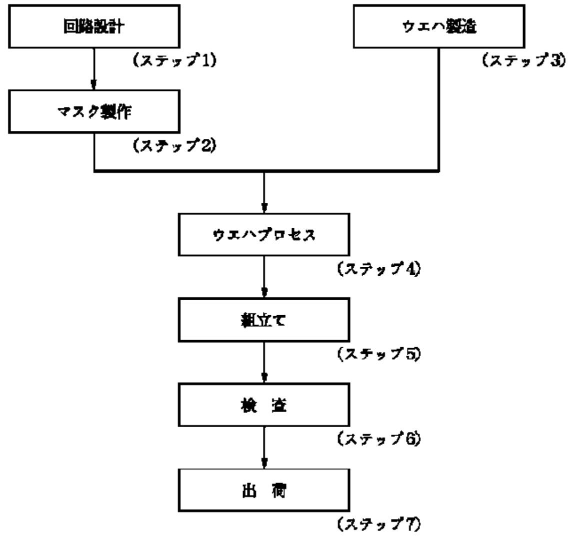

153A
169A
153B
165A
151A
13
167A
22
167B
151B
169B
165B

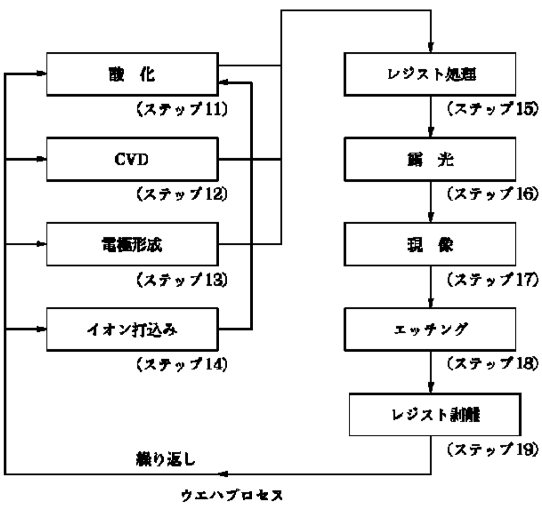

701
702
703
704
705
79
80
81a～c
排気
707
708
706

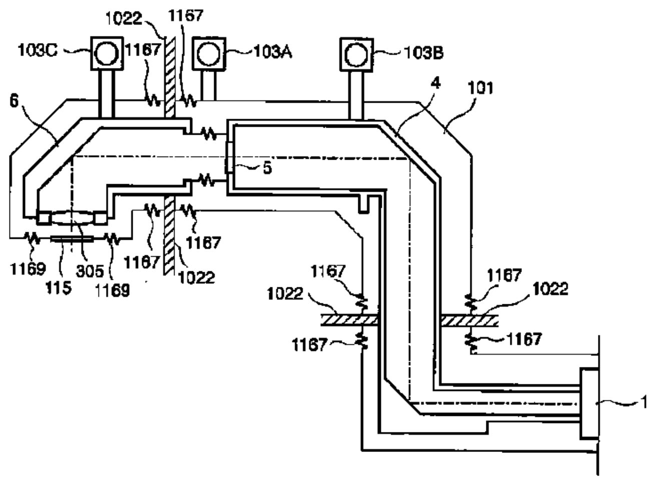

110
110
110
101
109
108
105
102
107
107
104
111
111
106
107
106
103
111
106


204
203
203
202
202
205
201
206
200
210
211
221
220
231
230


URL http://www.maintain.co.jp/db/input.html
トラブルDB入力画面
発生日 2000/3/15
404
機種 **********
401
件名 動作不良(立上時エラー)
403
機器S/N 465NS4580001
402
緊急度 D
405
症状 電源投入後LEDが点滅し続ける
406
対処法 電源再投入(起動時に赤ボタンを押下)
407
経過 暫定対処済み
408
送る
リセット
410
411
412
結果一覧データベースへのリンク
ソフトウェアライブラリ
操作ガイド


回路設計
(ステップ1)
ウエハ製造
(ステップ3)
マスク製作
(ステップ2)
ウエハプロセス
(ステップ4)
組立て
(ステップ5)
検査
(ステップ6)
出荷
(ステップ7)


酸化
(ステップ11)
CVD
(ステップ12)
電極形成
(ステップ13)
イオン打込み
(ステップ14)
レジスト処理
(ステップ15)
露光
(ステップ16)
現像
(ステップ17)
エッチング
(ステップ18)
レジスト剥離
(ステップ19)
繰り返し
ウエハプロセス


1022
1167
103C
1167
103A
103B
6
4
101
5
1167
1169
305
1167
1022
115
1169
1167
1022
1167
1022
1167
1167
1

【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第７部門第２区分
【発行日】平成20年5月8日(2008.5.8)

【公開番号】特開2001-345262(P2001-345262A)
【公開日】平成13年12月14日(2001.12.14)
【出願番号】特願2001-85531(P2001-85531)
【国際特許分類】
　Ｈ０１Ｌ　21/027　　(2006.01)
　Ｇ０３Ｆ　　7/20　　(2006.01)
【ＦＩ】
　Ｈ０１Ｌ　21/30　　５１６Ｆ
　Ｇ０３Ｆ　　7/20　　５２１
　Ｈ０１Ｌ　21/30　　５０２Ｇ
　Ｈ０１Ｌ　21/30　　５１５Ｄ
　Ｈ０１Ｌ　21/30　　５１６Ｚ

【手続補正書】
【提出日】平成20年3月24日(2008.3.24)
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項１】
露光装置であって、
光学素子を内部に有するチャンバーと、
前記チャンバーを囲む密閉容器と、
前記チャンバー内を減圧するポンプとを有し、
前記チャンバー内を減圧するときに、前記密閉容器も減圧することを特徴とする露光装置。
【請求項２】
前記チャンバーは、前記密閉容器に支持されていることを特徴とする請求項１に記載の露光装置。
【請求項３】
前記チャンバーと前記密閉容器との間で変位を発生させる変位機構を有することを特徴とする請求項１または２に記載の露光装置。
【請求項４】
基準部材と前記チャンバーとの間の位置関係を計測する計測器を有することを特徴とする請求項１乃至３いずれか１項に記載の露光装置。
【請求項５】
基準部材と前記チャンバーとの間の位置関係を計測し、該計測結果に基づいて前記変位機構を制御することを特徴とする請求項３に記載の露光装置。
【請求項６】
前記チャンバーは、前記光学素子を保持する鏡筒を支持する定盤に支持されていることを特徴とする請求項１に記載の露光装置。
【請求項７】
前記密閉容器は、可動体を介して前記定盤と連結することを特徴とする請求項６に記載の露光装置。

【請求項８】
前記可動体は、ベローズであることを特徴とする請求項７に記載の露光装置。
【請求項９】
前記ポンプは、前記密閉容器内の気体を排出することを特徴とする請求項１に記載の露光装置。
【請求項１０】
前記ポンプは、前記密閉容器内の気体を排出することで、前記チャンバーに設けられた通気孔を介して該チャンバー内の気体を排出することを特徴とする請求項９に記載の露光装置。
【請求項１１】
前記ポンプは、前記チャンバー内の気体を排出することを特徴とする請求項９または１０に記載の露光装置。
【請求項１２】
前記チャンバーは、照明光学ユニットの少なくとも一部の光学素子を内部に有することを特徴とする請求項１に記載の露光装置。
【請求項１３】
前記チャンバーは、投影光学ユニットの少なくとも一部の光学素子を内部に有することを特徴とする請求項１に記載の露光装置。
【請求項１４】
前記チャンバー内を減圧した後に、不活性ガスを供給する手段を更に備えることを特徴とする請求項１に記載の露光装置。
【請求項１５】
前記チャンバー内の減圧は、複数回行われることを特徴とする請求項１に記載の露光装置。
【請求項１６】
前記チャンバーは、ガス供給口とガス排出口とを有することを特徴とする請求項１に記載の露光装置。
【請求項１７】
前記チャンバーは、真空紫外域の光の光路の少なくとも一部を囲むことを特徴とする請求項１に記載の露光装置。
【請求項１８】
露光装置であって、
光学素子を内部に有するチャンバーと、
前記チャンバー内を不活性ガス雰囲気にする機構と、
前記チャンバーを囲む密閉容器とを有し、
前記チャンバー内の不活性ガスの純度は、前記密閉容器内の不活性ガスの純度よりも高いことを特徴とする露光装置。
【請求項１９】
前記密閉容器内の不活性ガスの純度は、該密閉容器外の不活性ガスの純度よりも高いものであることを特徴とする請求項１８に記載の露光装置。
【請求項２０】
前記機構は、チャンバー内を不活性ガス雰囲気にする前に、前記チャンバー内にある気体を真空排気することを特徴とする請求項１８に記載の露光装置。
【請求項２１】
前記チャンバーは、照明光学ユニットの少なくとも一部の光学素子を内部に有することを特徴とする請求項１８に記載の露光装置。
【請求項２２】
前記チャンバーは、投影光学ユニットの少なくとも一部の光学素子を内部に有することを特徴とする請求項１８に記載の露光装置。
【請求項２３】

前記チャンバーは、真空紫外域の光の光路の少なくとも一部を囲むことを特徴とする請求項１８乃至２２のいずれか１項に記載の露光装置。

【請求項２４】

露光装置であって、

光学素子を内部にするチャンバーと、

前記チャンバー内を不活性ガス雰囲気にする機構と、

前記チャンバーを囲む密閉容器とを有し、

前記チャンバー内の圧力は、前記密閉容器内の圧力よりも高いことを特徴とする露光装置。

【請求項２５】

前記密閉容器内の不活性ガスの圧力は、前記密閉容器外の不活性ガスの圧力よりも高いものであることを特徴とする請求項２４に記載の露光装置。

【請求項２６】

前記機構は、チャンバー内を不活性ガス雰囲気にする前に、前記チャンバー内にある気体を真空排気することを特徴とする請求項２４に記載の露光装置。

【請求項２７】

前記密閉容器は、光を透過させる透過窓を有することを特徴とする請求項１、請求項１８、請求項２４のいずれか１項に記載の露光装置。

【請求項２８】

前記透過窓は、フッ素化合物ガラスからなることを特徴とする請求項２７に記載の露光装置。

【請求項２９】

前記透過窓は、前記密閉容器に対して移動可能に支持されることを特徴とする請求項２７または２８に記載の露光装置。

【請求項３０】

前記密閉容器は、開閉扉を有することを特徴とする請求項１、請求項１８、請求項２４のいずれか１項に記載の露光装置。

【請求項３１】

前記チャンバーと前記密閉容器との間を連通させる通気孔を有することを特徴とする請求項１、請求項１８、請求項２４のいずれか１項に記載の露光装置。

【請求項３２】

前記通気孔は、開閉自在であることを特徴とする請求項３１に記載の露光装置。

【請求項３３】

前記チャンバーは、照明光学ユニットの少なくとも一部の光学素子を内部に有することを特徴とする請求項２４に記載の露光装置。

【請求項３４】

前記チャンバーは、投影光学ユニットの少なくとも一部の光学素子を内部に有することを特徴とする請求項２４に記載の露光装置。

【請求項３５】

前記不活性ガスは、ヘリウムと窒素のうちのいずれか一方であることを特徴とする請求項１４、請求項１８乃至２０、請求項２４乃至２６のいずれか１項に記載の露光装置。

【請求項３６】

前記チャンバーは、真空紫外域の光の光路の少なくとも一部を囲むことを特徴とする請求項２４に記載の露光装置。

【請求項３７】

ガス置換方法であって、

光学素子を内部に有するチャンバーの内部を減圧する工程と、

前記チャンバーを囲む密閉容器を減圧する工程と、

前記チャンバーの内部に不活性ガスを供給する工程と、

を有することを特徴とするガス置換方法。

【請求項３８】
ガス置換方法であって、
光学素子を内部に有するチャンバーの内部に不活性ガスを供給する工程と、
前記チャンバーを囲む密閉容器に不活性ガスを供給する工程と、
前記チャンバー内の不活性ガスの純度を、該密閉容器内の不活性ガスの純度よりも高い状態に制御する工程と、
を有することを特徴とするガス置換方法。
【請求項３９】
半導体デバイス製造方法であって、
請求項１乃至３６のいずれか１項に記載の露光装置を含む各種プロセス用の製造装置群を半導体製造工場に設置する工程と、
前記製造装置群を用いて複数のプロセスによって半導体デバイスを製造する工程と，
を有することを特徴とする半導体デバイス製造方法。
【請求項４０】
露光装置であって、
光学素子を内部に有するチャンバーと、
前記チャンバーを囲む密閉容器と、
前記密閉容器内を減圧するポンプと、
を有し、
前記チャンバーは定盤に支持され、前記密閉容器は変形を吸収するための第１の可動体を介して前記定盤と連結することを特徴とする露光装置。
【請求項４１】
前記第１の可動体は、ベローズであることを特徴とする請求項４０に記載の露光装置。
【請求項４２】
前記密閉容器の変形を吸収するための第２の可動体を更に備え、
前記第２の可動体は透過窓を保持し、前記透過窓は前記内部の光学素子に対して所定の位置関係に保持されることを特徴とする請求項４０に記載の露光装置。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】発明の名称
【補正方法】変更
【補正の内容】
【発明の名称】露光装置、ガス置換方法、半導体デバイス製造方法
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】００００９
【補正方法】変更
【補正の内容】
【００００９】
上記の目的を達成するための本発明の露光装置は、
光学素子を内部に有するチャンバーと、
前記チャンバーを囲む密閉容器と、
前記チャンバー内を減圧するポンプとを有し、
前記チャンバー内を減圧するときに、前記密閉容器も減圧することを特徴とする。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】００２３
【補正方法】変更
【補正の内容】
【００２３】

さらに、本発明の別の露光装置は、
光学素子を内部に有するチャンバーと、
前記チャンバー内を不活性ガス雰囲気にする機構と、
前記チャンバーを囲む密閉容器とを有し、
前記チャンバー内の不活性ガスの純度は、前記密閉容器内の不活性ガスの純度よりも高いことを特徴とする。
【手続補正５】
【補正対象書類名】明細書
【補正対象項目名】００２９
【補正方法】変更
【補正の内容】
【００２９】
さらに、本発明の別の露光装置は、
光学素子を内部にするチャンバーと、
前記チャンバー内を不活性ガス雰囲気にする機構と、
前記チャンバーを囲む密閉容器とを有し、
前記チャンバー内の圧力は、前記密閉容器内の圧力よりも高いことを特徴とする。
【手続補正６】
【補正対象書類名】明細書
【補正対象項目名】００４３
【補正方法】削除
【補正の内容】